FEB 9 1911

February 7, 1911.

POWER

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THE Waterproof Quality Of Schierens DUXBAK Belting And What It Means To Belt Users

It means more power from the fuel burned

It means an even length of belts in all weathers and climates

It means greater value through its extreme lasting quality.

It means that acid and other fumes have no bad effect on "Duxbak"

It means that the quality is so uniformly superior that Schieren can give the broadest kind of a guarantee

Send for price list and our circular matter; both are part of our selling plan.

Chas. A. Schieren Company
ESTABLISHED 1868

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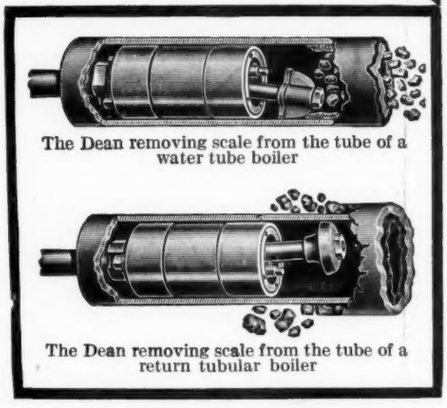
OAK LEATHER TANNERIES, Bristol, Tenn.

The Tube Cleaner That Cleans The Tubes Clean

If you knew the tremendous difference in steaming capacity, in wear and tear, in the annual coal bills between a near clean and a thoroughly clean boiler, you wouldn't be so indifferent in the selection of the means you use for combating scale.



The Dean removing scale from the tube of a water tube boiler

The Dean removing scale from the tube of a return tubular boiler

Now here's a tube cleaner that has made an enviable record as a scale remover—for water tube as well as tubular boilers.

It removes scale by vibration and takes off the scale clear down to the metal—10 to 30 tubes an hour.

In speaking of its work in a tubular boiler one user writes: "*The scale rattled off the tubes like hickory nuts after a frost.*"

Another writer, speaking of its work in a water tube boiler, says: "*We have been removing scale ½" thick that our Turbine Cleaners could not loosen at all.*"

Over and over again this tube cleaner—

Free Trial Offer

We will loan you a Dean for free trial in one boiler.

We want you to see the superiority of the Dean-way of removing scale.

You may return it at our expense after trial if you think you can afford to get along with the old-way.

The Dean Boiler Tube Cleaner

—has removed from 200 to 800 pounds of scale from a boiler thought to be clean, and has paid for itself in one cleaning.

Yes, there's abundant reason why you should know this cleaner—this fuel saver, labor saver, money saver.

And we **want** you to.

Read our free trial offer and just remember that **you** get the lion's share of the advantages—and we take the risks.

Write for booklet 130

The Wm. B. Pierce Co.

Jewett Building **Buffalo, N. Y.**

Chicago Office: 1201 Monadnock Building

POWER

NEW YORK, FEBRUARY 7, 1911

A WELL KNOWN engineer recently made the statement that he secured his first position as chief because he had formed the habit of doing his work right.

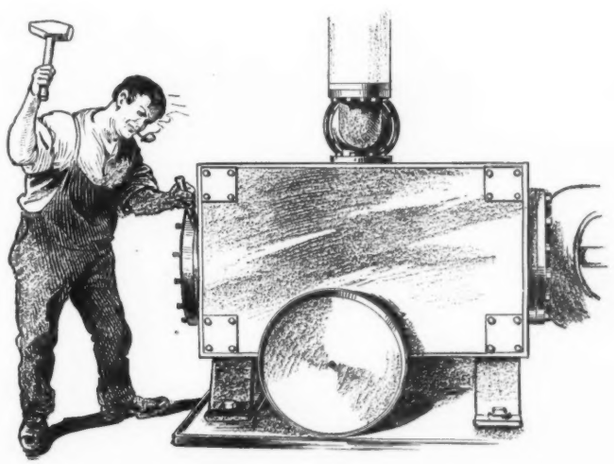
He had been an erecting man for an engine company, and was one of half a dozen men sent to make a new engine run satisfactorily. Five of them simply expressed their opinion as to the cause of the trouble and went away. This engineer used common sense, took off his coat and fixed the engine by making proper adjustments.

He did not know that an impression had been made with the head of the steam plant, but two years later, when he had forgotten the incident, he was offered the position of chief engineer of the very same plant where he had been sent to fix the engine.

The biblical maxim about casting bread upon the water and its return after many days worked out in this case. It usually does, and this man's experience is evidence that when a piece of work is to be done, it pays to do it the very best one knows how.

Some engineers are born, others are made and a whole lot are misfits.

Some engineers pride themselves on the appearance of their steam plant, and take as much care of their engines as if they were living things. Others, from lack of ambition, or because they have never learned to do things right, misuse everything under their care, and do so with apparent relish. Imagine a big, strong, bare-armed engineer taking a delicate steam gage and pounding the pointer in place on the spindle with a heavy hammer. It has been done.



Imagine this same individual, in an attempt to remove a cylinder head, gripping a cold chisel in one hand and a small-sized sledge hammer in the other and mauling with main strength until the heavy head is forced from the cylinder.

Such practice is enough to make a real engineer grind his teeth and protest against such methods of treating power-plant apparatus. Doing work in this way is often the direct reason why certain engineers are never given the opportunity of taking charge of a better plant than the one they have been operating for years.

No sane man expects to obtain something for nothing, and if a return is desired an investment must be made.

On the part of the engineer this means an intelligent understanding of steam engineering and the gumption to do the work around the plant in a workmanlike manner.

A pig will never be invited into the parlor, a common laborer will never be offered work as a skilled toolmaker, and an engineer using sledge-hammer methods cannot expect that an opening in some new, uptodate power plant is awaiting his coming.

A position of this kind demands a real engineer. Such a man is easily recognized by his methods and the results he obtains in the plant.

Boilers and Piping of Wieboldt Bl'dg

By Osborn Monnett

The main points of interest in this small plant of a Chicago department store are the boiler setting, which was specially designed for restricted head room, and the piping layout.

A new plant which has lately been installed for W. A. Wieboldt & Co., of Chicago, contains some features deserving of attention. The boiler room contains four Kroeschell 72-inch by 18-foot horizontal, return-tubular boilers, arranged in two batteries, as shown in Fig. 1, and fitted with Green chain-grate stokers. Owing to the fact that the sewer level at this point is close to the surface, severe restrictions as to the amount of headroom were imposed. The ordinary setting, which requires considerable excavation, was not desirable, not only because of its first expense, but also because of the continued expense for pumping into the sewer. Therefore the stokers were equipped with ash drags, as shown in Fig. 2, by which the ashes are pushed from the rear of the ashpit to a shallow pit at the front. The drag is composed of angle-iron sections attached to a chain operating over two sprockets which are driven from the stoker lineshaft through a ratchet arrangement keyed to the front drag shaft.

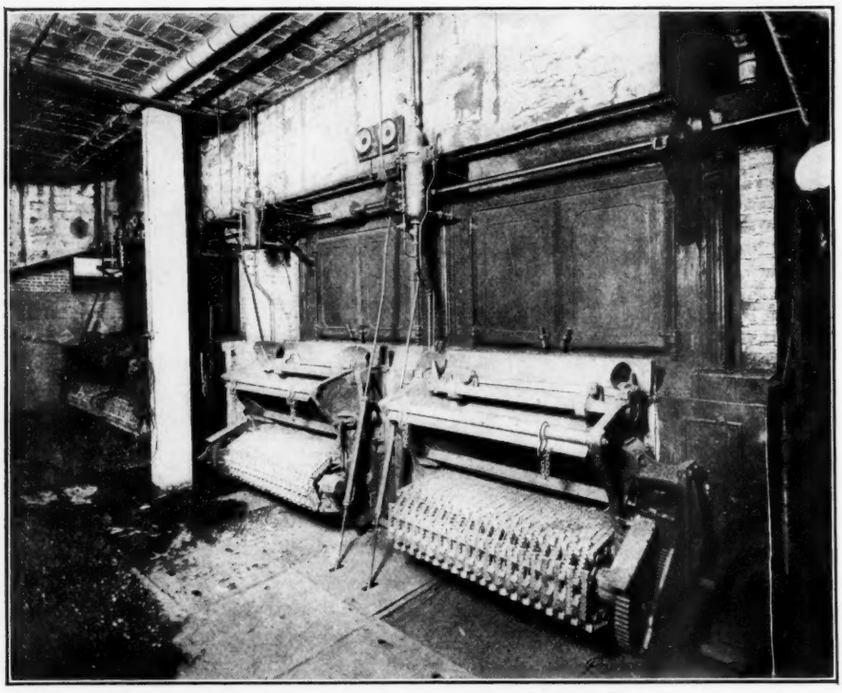


FIG. 1. FRONTS OF BOILERS

The system of piping is unique, and has been found very satisfactory. It conforms to the standard practice of W. L. Fergus & Co., the consulting engineers who laid out the new installation, and consists chiefly of a number of small headers and large receiver-separators, the latter located at the engine throttles and designed to furnish a reserve steam capacity to draw upon when the steam valves are open. A portion of the main piping is shown in Fig. 3.

The nonreturn valves connect with long-radius bends which terminate in a manifold located between the two batteries of boilers. At this manifold are located the boiler stop valves, all of which can be manipulated from this point by the operator, standing on a platform provided for the purpose. From the manifold a 6-inch straight header extends directly to the engine room, where branches are provided to distribute the live steam to the engines.

In the engine room there are three direct-connected Ball & Wood units, one of 50, one of 150 and one of 200 kilowatts capacity. Directly over each throttle is located a Cochrane receiver-separator of unusually large capacity for the size of engine. In the case of the 200-kilowatt unit a steam connection 8 inches in diameter is provided at the throttle, although the main steam line to this unit is only 4 inches in diameter. The steam line to the 150-kilowatt unit is 3 inches in diameter, the separator 30 inches in diameter and the throttle-valve connection as provided on the engine is 7 inches. Fig. 4 is a striking illustration of the comparative sizes of piping and separators. Another important feature is the use of an angle throttle valve, which affords a more direct passage for the steam.

The advantages claimed for this system of piping are lower first cost, greater safety, less maintenance cost for bolts and gaskets, reduced radiation, less surface exposed to the steam and consequent minimum condensation, avoidance of dangerous pulsations in the header over the boilers, as is sometimes found in ordinary layouts, and lower maximum velocity of the steam than in standard practice. It is claimed that a steady, constant flow of steam from the boilers to the separators is realized, which takes up any unevenness in the demand for steam

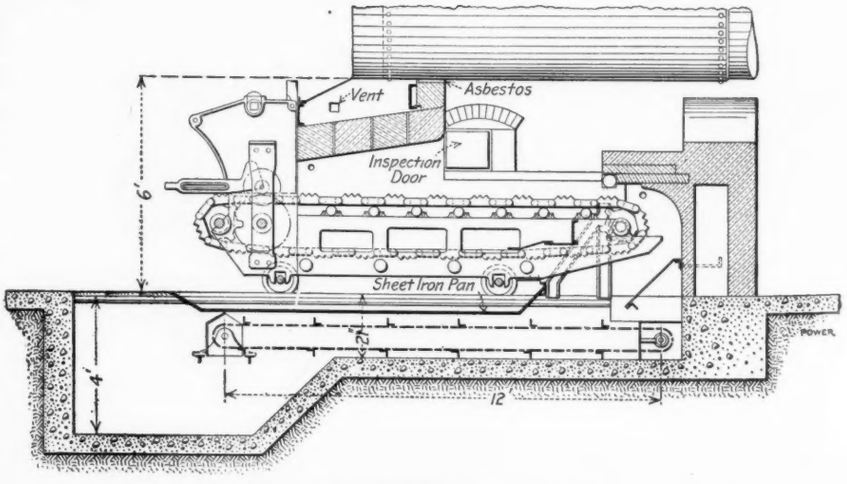


FIG. 2. SECTION THROUGH FURNACE

to the engines. No drain is used on the header system, as it is contended that condensation will cause the least trouble at the separator, where the steam is comparatively at rest, and the water will naturally gravitate to the bottom, where it is easily removed.

Fig. 5 shows an indicator diagram taken on one of the engines running under full load, and serves as an indication of how well the system is working out.

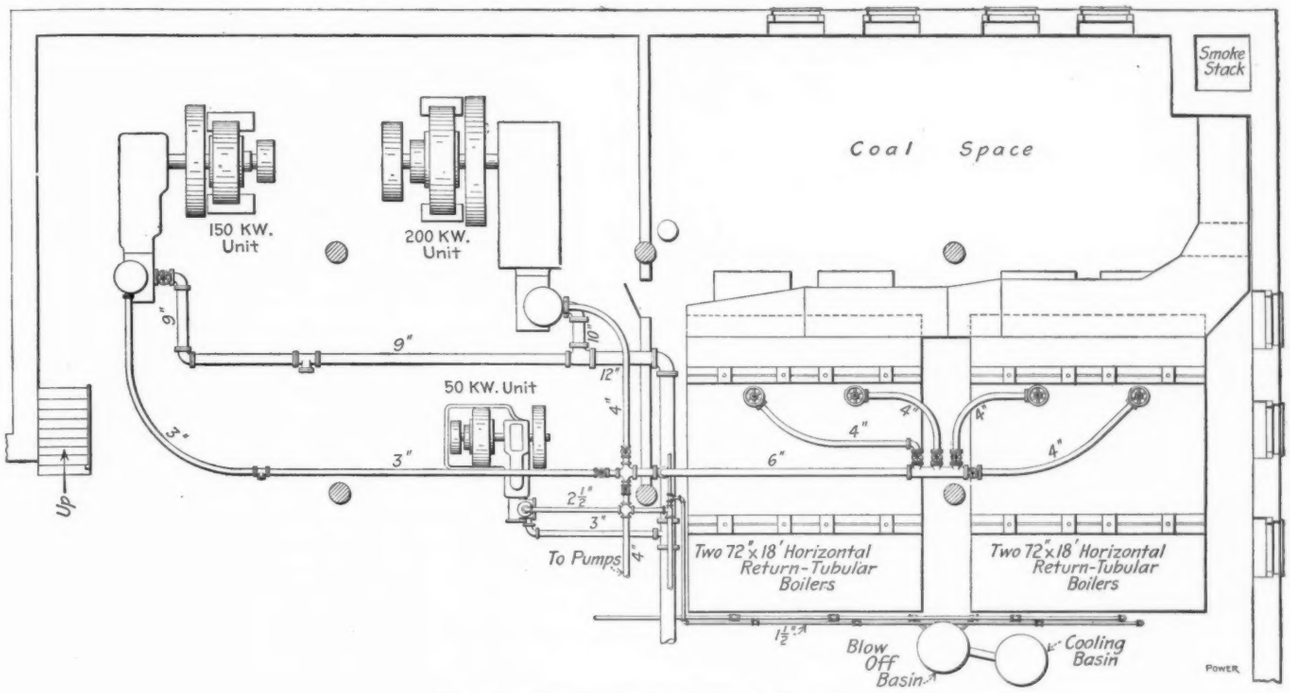


FIG. 3. LAYOUT OF MAIN STEAM PIPING

The Oldest Complete Locomotive in America

At the National Museum in Washington, is exhibited the locomotive "John Bull," No. 1 of the Camden & Amboy Railroad Company, which was built by George Stephenson & Son at Newcastle-on-Tyne in 1830-31 and shipped from Liverpool on July 14, 1831, on the ship "Allegheny," bound for Philadelphia. On November 12, 1831, in the presence of members of the New Jersey legislature, with Isaac Dripps acting as engineer, and a train with two cars, this locomotive made the first movement by steam in the State of New Jersey, at Bordentown, where the railroad monument now stands. The "John Bull" was in continuous service from 1831 to 1865, during which time it was altered and added to. It was exhibited at the centennial exposition in 1876 and at the exhibition of railway appliances in Chicago in 1883. It was placed in the United States National Museum in 1883 and remained there until 1893, when on April 17 to 22 it was run under steam from New York to the World's Columbian Exposition, where, for a time, it made daily trips on the exposition tracks. In December, 1893, it was returned to Washington, having made the last trip under steam on the thirteenth of that month. The original weight was 22,425 pounds. The boiler was 13 feet long, 3 feet 6 inches in diameter; the cylinders, 9x20 inches; the driving wheels, 4 feet 6 inches in diameter, with locust spokes, cast-iron hubs, with tires of wrought iron shrunk on; the flanges, 1½ inches deep; 62 flues, 7 feet 6 inches long, 2 inches in diameter; furnace, 3 feet 7 inches by 3 feet 2 inches high; steam ports, 1⅛x6½ inches; exhaust ports, 1½x6½ inches; throw of the eccentric, 3½ inches; grate surface, 1008 square feet; fire-box surface, 36 square feet; flue surface, 213 square feet. There is also exhibited in the same section one of the original driving wheels of the "De Witt Clinton."

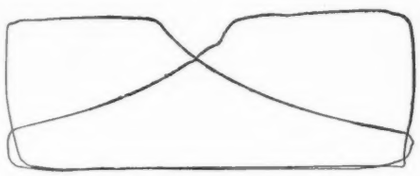


FIG. 5. DIAGRAMS SHOWING EFFECT OF STEAM RECEIVERS

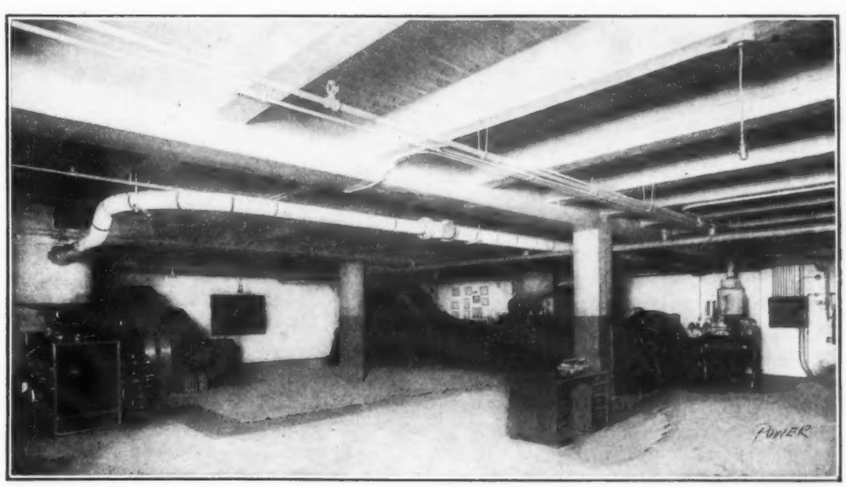


FIG. 4. ENGINE ROOM, SHOWING LARGE RECEIVERS

One of the best preventatives of scale in a boiler is good circulation of the water contained within.

Design of Steam Power Plants

By William F. Fischer

In a previous article under the above caption are taken up the location and type of plant, the building and the foundations. The present article deals with the selection of boilers.

In aiming for economy of fuel the whole equipment of boilers, engines, condensers, pumps, heaters, piping, etc., must be considered individually and collectively. An inefficient boiler will counteract the virtues of a good engine, and likewise an engine extravagant in steam may render useless the economy obtained with a good boiler.

Selection of the Boilers

Before the plans for the boiler house are completed, the type of boiler to be used should first be decided upon and its exact dimensions and setting obtained from the manufacturer.

As the efficiency of a steam-power plant, both thermally and commercially, depends primarily upon the boiler installation, it is evident that the selection of proper boilers is of utmost importance. A well selected boiler may give fairly economical results even when poorly installed, but a type of boiler entirely unfitted for the duty imposed upon it may have the best setting and still not give good results. The first cost, though important, should not be the first consideration in selecting any piece of apparatus for a power plant; selecting steam boilers wholly on account of their low first cost frequently means a sacrifice in efficiency and with it the profits on the investment. If, on the other hand, boilers are selected with reference only to their thermal efficiency, the cost of the installation may be prohibitive, and for this reason may forbid a decision wholly upon that basis.

Evaporation

The principal item affecting the cost of operation of a boiler is its evaporative efficiency, which should be a maximum at normal load in a well designed boiler. When forcing to a great extent, although the rate of evaporation is increased, the efficiency is lowered owing to a large proportion of the heat being wasted. Therefore, a boiler plant should be of ample capacity to carry the greatest steady loads without forcing. It is always well to install one or more spare boilers, for use when any of the others are out of service for repairs or for cleaning.

With most boilers the best efficiency under ordinary working conditions is obtained when evaporating about three pounds of water per hour, per square foot of heating surface, from and at 212 degrees. This is equivalent to allowing nearly twelve square feet of heating surface per boiler horsepower.

As the efficiency of the heating surface will be more or less impaired by the accumulation of scale and soot, it is well to provide ample heating surface for the work to be done. This results in a saving of fuel at ordinary rates of evaporation, and also makes it possible to run the boiler considerably above its rating and still maintain a fair efficiency.

Most of the various types and grades of boilers on the market are capable of producing practically the same evaporation per pound of fuel fired, provided they are designed with the same ratio of heating to grate surface and are operated under exactly similar conditions. They differ, however, with respect to space occupied, weight, capacity, first cost and adaptability to particular conditions of operation.

Boiler Horsepower

Strictly speaking, there is no such thing as the horsepower of a steam boiler, for the power from the steam is developed in the engine, the boiler itself doing no work. This phrase was originally intended to mean that a boiler having a certain stated horsepower would furnish all the steam required to develop that amount of power in a given engine. According to the American Society of Mechanical Engineers' standard, a boiler to develop one horsepower must evaporate 30 pounds of water from a temperature of 100 degrees Fahrenheit into steam at 70 pounds gage. This is equivalent to evaporating 34½ pounds of water from a temperature of 212 degrees Fahrenheit into steam at atmospheric pressure, or "from and at 212 degrees," as it is called, which corresponds to 33,305 B.t.u. per hour.

This measure of capacity is merely conventional, as one boiler horsepower will furnish sufficient steam to develop about three actual horsepower in the best compound-condensing engine, but only about one-half horsepower in a small noncondensing engine.

The term "horsepower" should not be used when purchasing a boiler unless the amount of heating surface is also specified, as one bidder might offer a boiler with five square feet of heating surface per horsepower, and another with ten square feet. Both boilers would be capable of the required evaporation, but the boiler having the smaller heating surface, although probably much the cheaper of the two, would do so only at an increased fuel consumption.

Water-tube versus Fire-tube Boilers

Engineers differ as to the design of boiler best suited to certain conditions. As experience has shown that boilers of the water-tube and the fire-tube types give equally good economy if well designed and operated under the same conditions, it is impossible to give any general rule as to which type should be given the preference. The principal considerations with which an engineer has to deal when selecting a type of boiler for a given plant are: The character of the fuel, the character of the feed water; the kind of service and safety, the available floor space, the steam pressure to be carried, the expense of operation and maintenance, and the influence of the locality.

Water-tube boilers are usually employed in medium- and large-sized central stations in high-pressure units of from 300 to 650 horsepower. Where the service is such that large quantities of steam are often wanted with but very little warning, water-tube boilers should always be given the preference. This is because they contain relatively less water than the shell, or fire-tube, type; consequently steam can be raised in them within a shorter time. On account of the larger passage for the gases and the better circulation of water in contact with the heating surfaces, more water can be evaporated per square foot of heating surface in a water-tube boiler than in one having fire tubes, although, as before mentioned, the efficiency of the two types is about the same. On account of their lower first cost, return-tubular boilers are still used to a considerable extent in central-station work in preference to the water-tube type, but as the practice of such initial economy frequently proves to be the most expensive in the end, the consideration of low first cost should not be given too much weight. By this, however, is not meant that the boiler of highest first cost is always the most economical one. Regarding repairs, the water-tube boiler is the more expensive if it is to be kept in first-class condition.

Waters that abound in scale-forming matter warrant a decision in favor of the use of a boiler of the plain cylindrical or horizontal return-tubular types, because of the comparative ease with which they can be cleaned at a minimum cost. Because of their ability to stand almost continual service with a minimum amount of overhauling, horizontal return-tubular boilers should be given the preference where the time allowable for repairing, cleaning and overhauling is limited.

As to safety, water-tube boilers are generally accepted to be superior to those

of the fire-tube type. Therefore, in selecting the boilers for a building where a number of people are employed, or are likely to be gathered, the water-tube type should undoubtedly be given the preference, regardless of its additional first cost and cost of operation and maintenance.

Another important consideration in the selection of a steam boiler is the amount of space available. For shallow basements and out of the way corners, probably no boiler is as suitable as the horizontal return-tubular, but where space is plentiful, other considerations may cause a different type of boiler to be selected. As return-tubular boilers are seldom made in sizes over 200 horsepower, they should not be considered for large units.

Vertical Boilers

Where ground space is expensive and overhead room permits, vertical tubular boilers may be considered. As a rule, such boilers are rapid steamers and are comparatively low in first cost. They have the disadvantages, however, of being inaccessible for thorough inspection and cleaning, have a considerably small steam space, resulting in excessive priming at heavy loads, and are poor in economy except at light loads, as the products of combustion escape at a high temperature on account of the shortness of the tubes. Another disadvantage of the vertical tubular boiler is its small water capacity, which usually results in rapidly fluctuating steam pressures with varying demands for steam.

Vertical fire-tube boilers are usually of small size, seldom being over 60 horsepower. An exception, however, is found in the Manning vertical fire-tube boiler, which is constructed in sizes up to 500 horsepower, and suitable for steam pressures of 200 pounds or more. In sizes above 300 horsepower they are usually arranged with a brick furnace and may be equipped with mechanical stokers. As far as safety and efficiency are concerned, the Manning boiler ranks with any of the other first-class types. Vertical boilers are also made in the water-tube type, and in efficiency compare favorably with the horizontal water-tube boiler.

Available Labor

Another important consideration which should not be overlooked in selecting steam boilers is the class and amount of labor available to operate and take care of them. A plant in which there is only one attendant should, as a rule, never be equipped with water-tube boilers, as the attendant will not have sufficient time to care for them properly.

Grate Surface and Draft

The maximum evaporative capacity of a steam boiler is limited mainly by the amount of coal which can be burned upon the grates. With sufficient draft a good boiler can develop a horsepower upon one-half the surface ordinarily recommended. The item of grate surface is one of vital importance, and should conform to the demands imposed upon it by the particular grade of fuel to be used.

Some coals, having less heating power per pound than others, cannot be burned at as high a rate of combustion on account of their peculiar properties. Therefore, the grate surface depends chiefly upon the character of the coal and the rate of draft. With good coal low in ash, approximately equal results may be obtained with a large grate surface and light draft as with a small grate surface and strong draft, the total amount of coal burned per hour being the same in both cases. With good bituminous coal, low in ash, the best results are obtained with a strong draft and a high rate of combustion, provided the grate surfaces are cut down so that the total coal burned per hour is not too great for the capacity of the heating surface to absorb the heat produced. With coals high in ash, especially if the ash is easily fusible, tending to choke the grates, large grate surface and a low rate of combustion are required unless means, such as shaking or rocking grates, are provided to get rid of the ash as fast as it is made. The amount of grate surface required per horsepower under various conditions may be estimated from the accompanying table, which is taken from Kent's "Mechanical Engineers' Pocketbook."

GRATE SURFACE PER HORSEPOWER.

	Pounds of Water from and at 212° Fahr. per Pound of Coal.	Pounds of Coal per Horsepower per Hour.	Pounds of Coal Burned per Square Foot of Grate per Hour.								
			8	10	12	15	20	25	30	35	40
			Square Feet of Grate per Horsepower.								
Good coal and good boiler	10	3.45	0.43	0.35	0.28	0.23	0.17	0.14	0.11	0.10	0.09
	9	3.83	0.48	0.38	0.32	0.25	0.19	0.15	0.13	0.11	0.10
Fair coal or fair boiler	8.61	4	0.5?	0.40	0.33	0.26	0.20	0.16	0.13	0.12	0.10
	8	4.31	0.54	0.43	0.36	0.29	0.22	0.17	0.14	0.13	0.11
	7	4.93	0.62	0.49	0.41	0.33	0.24	0.20	0.17	0.14	0.12
Poor coal or poor boiler	6.9	5	0.63	0.50	0.42	0.34	0.25	0.20	0.17	0.15	0.13
	6	5.75	0.72	0.58	0.48	0.38	0.29	0.23	0.19	0.17	0.14
	5	6.9	0.86	0.69	0.58	0.46	0.35	0.28	0.23	0.22	0.17
Lignite and poor boiler	3.45	10	1.25	1.00	0.83	0.67	0.50	0.40	0.33	0.29	0.25

This shows that a high-grade coal will permit of a more compact grate than a low-grade coal. When it is intended to burn a low-grade coal the grate should be made as ample as possible and if it is afterward desired to change to a coal of better grade, a portion of the grate may be bricked over, providing the draft, fuel or other conditions render it advisable. As a high rate of combustion is undoubtedly the best for many coals for the reason that the gases are much more thoroughly consumed when the furnace temperature is high, sufficient draft should be provided, either by a fan or chimney high enough to produce not only the proper rate of combustion for ordinary demands, but also to enable the boilers to operate with the desired overload. Not less than one-third square foot of grate surface should be furnished per horsepower.

Boiler Efficiency and Heating Surface

With the best types of boiler having the grate area and heating surfaces carefully proportioned, an efficiency of 75 to 80 per cent. is attainable with a clean boiler in exceptionally good condition and carefully managed.

It is a general practice among manufacturers to furnish about 11 to 12 square feet of heating surface for vertical fire-tube boilers and horizontal return-tubular boilers; ten to twelve square feet per horsepower for water-tube boilers; twelve to fourteen square feet for stationary locomotive boilers, and about eight square feet per horsepower for Scotch marine boilers. As this practice is not uniform, however, bids and contracts for boilers should always specify the amount of heating surface to be furnished.

Boiler Inspector's Fees

J. J. Kelly, State boiler inspector for Allegheny county, Penn., whose office Governor Stuart recommended in his message to the legislature to be made a salaried one instead of being remunerated by fees, gave out recently, according to a newspaper report, some figures in relation to his office and its income, wherein he stated that the fees of his office would approximate about $18,000 annually, out of which he has to pay aldermen's fees incurred in collecting some of the moneys for inspection and the wages of five assistants for inspecting boilers as well as office rent and telephone bills.

According to Mr. Kelly, there are less than 6000 boilers to inspect in the county, due to the fact that the gas and gasolene engines are used to such an extent that the number of boilers is decreasing, also that manufacturers are using fewer boilers but of greater horsepower.

The development of the central power plant is replacing the numerous small boilers in public buildings, which Mr. Kelly asserts has cut down the fees of his office.

Experiences on Construction Work

By S. Kirlin

Attention is called to the fact that on construction work the conditions are often such that when a breakdown occurs repairs must be made immediately. With the limited facilities at hand the repairs often tax the ingenuity of the engineering force. A few of such instances are cited.

Engineers of stationary plants sometimes think they have their share of trouble in keeping their plants in good operating condition, and they undoubtedly do have plenty of it at times; but, when it comes to having all kinds of trouble, and usually that of an unexpected character, the engineers and mechanics of outside contracting plants, such as canal construction, mine development and other plants of this kind, often have difficulties which make the ordinary troubles of the stationary engineer appear comparatively small.

On works of this kind, good buildings or foundations are not attempted, as the work is usually of a temporary character and the machinery must be moved about frequently; consequently, the machinery is operated under conditions which make accidents and breakdown much more liable to occur than in a plant which is installed to be operated permanently. On account of the nature of the work, it is often necessary for the boilers, engines and pumps to be placed in the bed of a stream and protected by a cofferdam, the water being pumped out continuously night and day, to prevent the works from being flooded. This makes quick action on the part of the men in charge necessary in case of a breakdown, especially if it happens to the pumping machinery. They must be resourceful, and quick to find a remedy for any emergency which may arise.

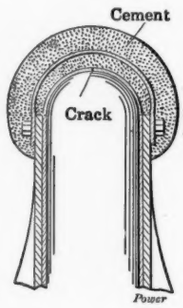


FIG. 1. SECTION THROUGH REPAIRED PORTION

While visiting plants of this kind in various parts of the country, the writer's attention frequently has been called to repairs that had been made to the machinery, many of which would have done credit to the best equipped machine shop. In most cases the work had been done with whatever tools were available, and in the shortest possible time in order to get the machinery in service again. One example of a quick and effective repair was that made on a large centrifugal pump on a hydraulic dredge. It began to leak on one side of the rim, and upon examination it was found that the rim was cracked and almost worn through for a distance of several feet. As there were no facilities at hand for patching it, the master mechanic decided to try repairing it with cement. Fig. 1, showing a cross-section of the pump, and Fig. 2, which shows an elevation of the finished repair, give an idea of how the job was accomplished. A number of pieces of strap iron were cut to the proper length with holes drilled in the ends to fit over the studs which held the sides of the casing. These were bent over the rim and were allowed to stand out about 3 inches to form a reinforcement for the cement. A form was then made, and, after being placed over the rim of the pump, was poured full of cement. As soon as this had set, the form was removed and the pump placed in service.

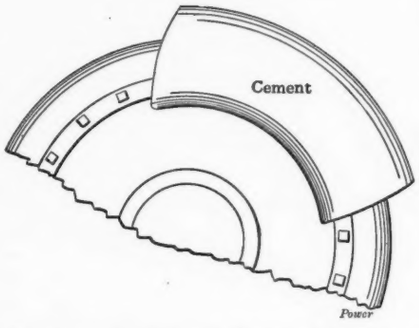


FIG. 2. ELEVATION OF REPAIRED PORTION

Another interesting repair was that made on a broken eccentric rod of a high-speed engine which drove an air compressor. The compressor furnished air for operating a large number of drills, and as all work was stopped while the air pressure was off, it was up to the engineer to make a quick repair and get things running again. He at once put two men to work filing grooves on each side of the break, as shown in Fig. 3. A piece of pipe 10 inches long and about ½ inch larger in diameter than the rod was then slipped over it, the ends of the broken rod being butted together. The rod was then centered in the pipe, the ends of which were stopped with clay, and the pipe was poured full of babbitt. As the rod had not been changed from its original length, it was not necessary to reset the valve or to disturb any of the connections. The engine was running again in less than an hour after the break had occurred.

The master mechanic of a large contracting firm who had a reputation for making quick repairs in case of a breakdown, was asked how it was that he was always ready with a remedy for all accidents that occurred. He answered that he made it a point to study the construction of every machine at the works, to ascertain just about what was most likely to break down, and to decide upon the method he would use to repair it in case it did let go. In this way he was prepared with the necessary material for making the repairs on breakdowns which were most likely to occur, and did not lose any time studying out a way to go at it. His system of being prepared for trouble before it occurred might be adopted by a great many others to good advantage.

There is probably no place where it pays better for the companies to furnish their mechanics with plenty of good tools than on work of this kind. It is usually a long distance from any machine shop where repairs can be made, and delay in making repairs is often a serious matter, as a small accident will frequently stop all work and possibly cause heavy damage by flooding work under way.

The chief engineer of a construction company which was notoriously lax when it came to furnishing tools, remarked, that they had a sledge, a monkey-wrench and a screwdriver, and were supposed to repair everything from the Ingersoll air compressor down to the master mechanic's watch of the same make.

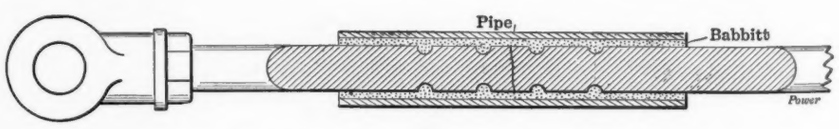


FIG. 3. SECTION THROUGH ROD AND BABBITT

Hen Simpkins packed th' piston rod uv his ingin tother day an' sez he'll bet thet he don't hev ter pack it agin fer a year. Sed his darter hed jist graddiated frum th' cookin' school an' he used sum uv her doughnuts, 'stid uv ring packin'.

Boiler Thirty Years Old Explodes

By Albert F. Dedrick

A 40-inch return-tubular boiler which had been in continuous service for twenty-four years in a grist mill, was taken out, left exposed to the weather for four years, and then installed in an electric-light plant where it operated for two years under a working pressure of 100 pounds.

On the evening of January 14, while a committee of engineers in St. Joseph, Mo., were busily engaged in drafting a proposed law relative to the licensing of engineers and firemen and the inspection of steam boilers throughout the State, the boiler of a small electric-light plant in the neighboring town of Rushville exploded. The fireman and his son, who had just dropped in to see his father, were instantly killed, and the entire plant was demolished. Fortunately the engineer, who was also the owner, had left the plant a few minutes before. If the explosion had occurred three-quarters of an hour later, it is probable that a dozen or more lives would have been lost, as it was customary for a number of the men and boys of the town to congregate around the plant every evening.

The boiler was built in 1881 for a Kansas grist mill, and after twenty-four years of service was sold to a mill in Rushville. The purchasers, after making a careful examination of the boiler, decided that it was not worth the expense of installing and therefore let it remain in the yard. After being exposed to the weather for four years it was installed in the electric-light plant where it had been in service for about two years when the explosion occurred.

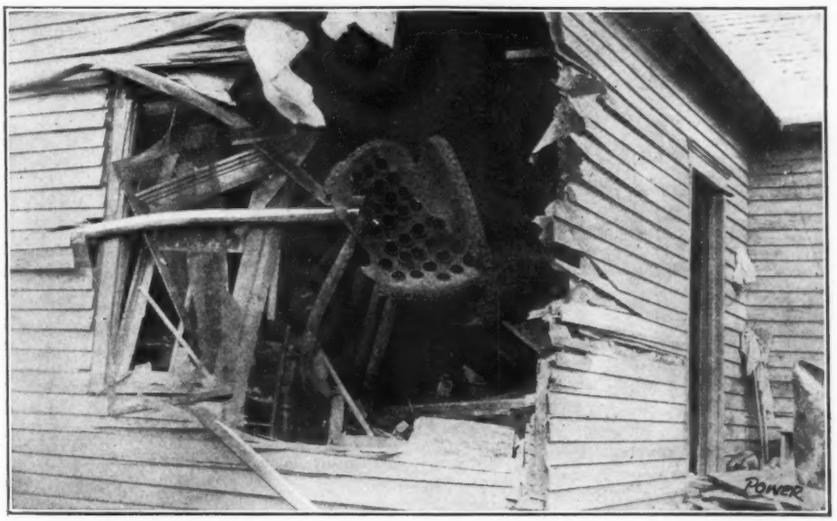


FIG. 1. HEAD AND TUBES HURLED THROUGH KITCHEN WALL

It was of the horizontal return-tubular type, 40 inches in diameter by 11 feet 6 inches long, and had single-riveted lap joints. The shell, which originally had been ¼ inch thick, was badly pitted on the inside and rusted away on the outside until in many places it measured less than ⅛ inch. The regular working pressure was 100 pounds per square inch and, with the safety valve, which was of the ball-and-lever type, set at 108 pounds the plate must have failed at a tensile strength of 17,000 pounds per square inch, providing the actual steam pressure did not exceed 108 pounds.

Some idea of the extent of the explosion may be gained from the accompanying views. The two heads with most of the flues intact were blown a distance of fifty feet through the kitchen wall of the owner's house, narrowly missing three small children who were asleep in an adjoining room. The dome and several sheets landed in the main street of the town, a distance of about 350 feet from the plant, while another large piece took a direction at right angles to this and landed in a creek.

FIG. 3. 200-POUND PIECE ON HILLSIDE, 500 FEET FROM ORIGINAL LOCATION

Upon being questioned after the explosion, the engineer admitted that there was a hole in the sheet just above the fire, through which water oozed, but he had not considered it serious enough to affect the safety of the boiler. From the

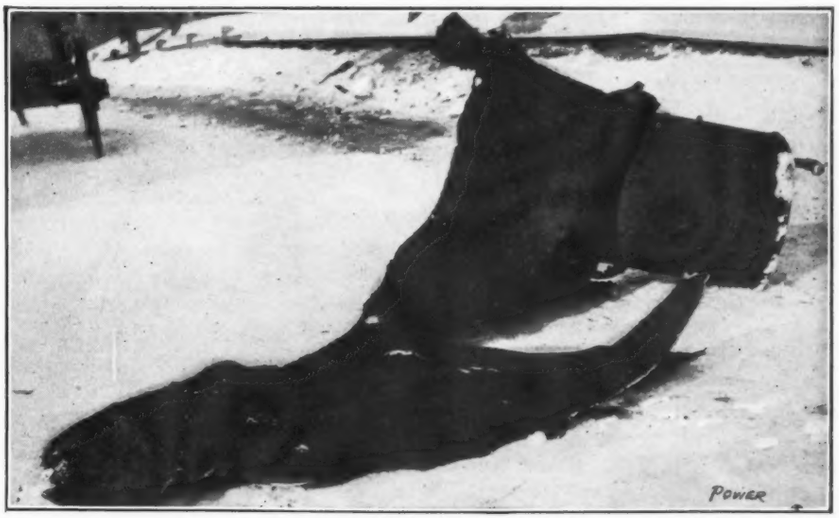


FIG. 2. DOME AND SHEETS

FIG. 4. SECTION OF SHELL THROWN 350 FEET

FIG. 5. REMAINS OF DYNAMO

directions in which the various parts of the boiler were hurled it is evident that the initial rupture occurred at the bottom of the shell, and in the absence of other indications it would seem more than likely that it took place at or near this hole, although the tremendous force exerted by the explosion would suggest a rupture above the water line.

Use of High Gas Speeds in Boilers

At a recent meeting of the Institution of Engineers and Shipbuilders of Scotland, Prof. J. T. Nicolson delivered a paper on "Boiler Economics and the Use of High Gas Speeds," based upon the tests of an experimental boiler of the Cornish type, this boiler being arranged as shown in Fig. 2. Within the last 10

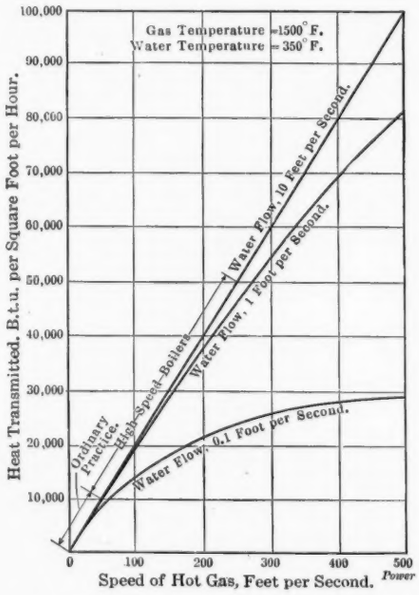


FIG. 1. EFFECT OF VELOCITY OF GASES UPON HEAT TRANSMISSION

feet of boiler flue was placed a brick plug of such a diameter as to leave an annular space 1½ inches around it for the passage of the hot gases. These, after leaving the boiler, passed over the tubes of an evaporator and then through an economizer. The tubes of both the evaporator and the economizer had

In this experimental boiler a gas speed of over 200 feet per second was attained, resulting in the transmission of 48,000 B.t.u. per square foot of boiler-heating surface and 2785 B.t.u. per square foot of economizer surface per hour. This resulted in a high rate of evaporation without decreasing the thermal efficiency.

square iron rods inserted within them so as to cause the feed water to travel at a rapid rate, yet bring as much water-heating surface into use as possible. It was arranged that the feed upon leaving the economizer should go either directly into the boiler, or go there after mixing with the circulating water drawn by a rotary pump from the boiler and forced through the tubes of the evaporator so as to accelerate the circulation.

The results of the tests with this arrangement were as follows:

Coal fired per hour, pounds	840
Coal fired per square foot of grate surface per hour, pounds	44.2
Temperature of gases in combustion chamber, degrees Fahrenheit	3000
Temperature of gases leaving brick plug, degrees Fahrenheit	1200
Temperature of gases leaving evaporator, degrees Fahrenheit	620
Temperature of gases leaving economizer, degrees Fahrenheit	140
Temperature of feed entering economizer, degrees Fahrenheit	70
Temperature of feed leaving economizer, degrees Fahrenheit	270 to 340
Temperature corresponding to boiler pressure, degrees Fahrenheit	340
Draft at fan suction, inches	23½
Draft at bottom of economizer, inches	23
Draft at top of economizer, inches	7
Draft at back of water drum, inches	6½

It will be observed that the temperature of the waste gases fell to within 70 degrees of that of the entering feed. Compared with a boiler plant in which the waste gases reach the chimney at 540 degrees, this corresponds to an increased evaporation of about 1½ pounds per pound of coal. The transmission through the heating surface surrounding the plug was,

$$840 \times 15 \times 0.25 \times (3000 - 1200) = 5{,}670{,}000 \text{ B.t.u.}$$

per hour, or 48,000 B.t.u. per hour per square foot of heating surface. In a similar manner it was found that the rate of heat transmission in the economizer was 2785 B.t.u. per square foot of tube surface per hour.

The effect of gas speed in promoting rapidity of heat transference was definitely established, as plotted in Fig. 1, and there seemed to be a possibility by its use of greatly reducing the ratio of heating to grate surface without causing a diminution in efficiency which heretofore has always been associated with forced rates of combustion and evaporation.

It was accordingly decided to keep the boiler in operation for several months, making regular temperature observations and weighing the coal and feed water. Some little difficulty was experienced at first with the fan, but slight alterations enabled it to successfully hold up under the severe service. The principal object in making this continuous test was to ascertain whether the narrow gas pas-

sages would become choked with soot, and to observe what would become of the sediment and gases contained in the feed water when set free in the narrow water channels of the economizer and evaporator.

As feared, the passages around the economizer tubes did become choked with soot, and in order to burn the required quantity of coal it was found necessary to remove about one-third the number of economizer tubes (which were ⅞ inch in diameter and pitched 1⅛ inches center to center) and repitch them. With this change the temperature of the waste gases no longer remained at 140 degrees, but rose to 240 degrees with a thin layer of soot upon them.

As regards the water spaces of the economizer (that remaining after a ½-inch square rod had been inserted in a ¾-inch pipe) no deposit was found upon either the rods or the pipe and there was practically no corrosion. Below the water level, however, the evaporator tubes had become partially obstructed by a white sediment. This was accounted for by the fact that during the night the water-circulating pump was always shut down owing to lack of current; consequently the only circulation through the evaporator was that due to gravity.

The results of a test after fifty-one days' steaming without overhauling, except for the removal of some of the sediment below the water level of the evaporator, are given in the accompanying table.

RESULTS OF CONTINUOUS RUN.

Coal burned per square foot of grate per hour	37.8	38.0	22.8	26.4	40.8	40.7
Water evaporated per pound of dry coal from and at 212 degrees	10.542	10.370	10.780	11.993	11.413	11.610
Evaporation from and at 212 degrees per square foot of boiler and evaporator surface	19.25	19.02	11.87	15.45	22.77	23.06
Evaporation from and at 212 degrees per square foot of total heating surface, including economizer	10.65	10.5	6.56	8.53	12.58	12.75
Thermal efficiency of boiler, per cent	77.4	76.8	79.1	77.6	73.8	75.0
Net efficiency, deducting steam for fan, per cent	66	66.8	68.9	69.1	64.4	66.1
Chimney loss, per cent	.....	6.7	6.7	6.4	5.4	5.8
Loss by incomplete combustion, per cent	.....	2	2.6	0.5	1.1	0.0
Loss due to coal dust blown away, radiation, etc., per cent	.....	15	11.3	13.2	16	13.3

In conclusion it may be said that the tests show:

1. That the rate of evaporation in pounds per square foot of total heating surface per hour increases directly with the gas speed.

2. This increased evaporative power can be attained without any sacrifice in evaporative or thermal efficiency.

3. The scouring action of the high-speed gas is sufficient to prevent choking by the accumulation of soot to such an extent as to affect materially the rate of heat transmission.

4. With continuous running, and a high rate of flow of the feed water in small-bore tubes, the deposit of sediment is avoided, and corrosion due to pitting is eliminated; that is, if the water is passed through the narrow spaces at a high speed while throwing off its impurities, and is then led into a large space where these may settle without danger or trouble before being passed through the evaporating tubes, the incrustation difficulty which has been advanced against the adoption of small tubes is obviated.

5. High drafts do not necessarily involve high rates of burning on the grate.

6. That the drop in temperature between the furnace and the stack does not depend upon the mere magnitude of the heating surface, but upon the ratio of the total heating surface to the cross-sectional area of all the flues through which the gases pass.

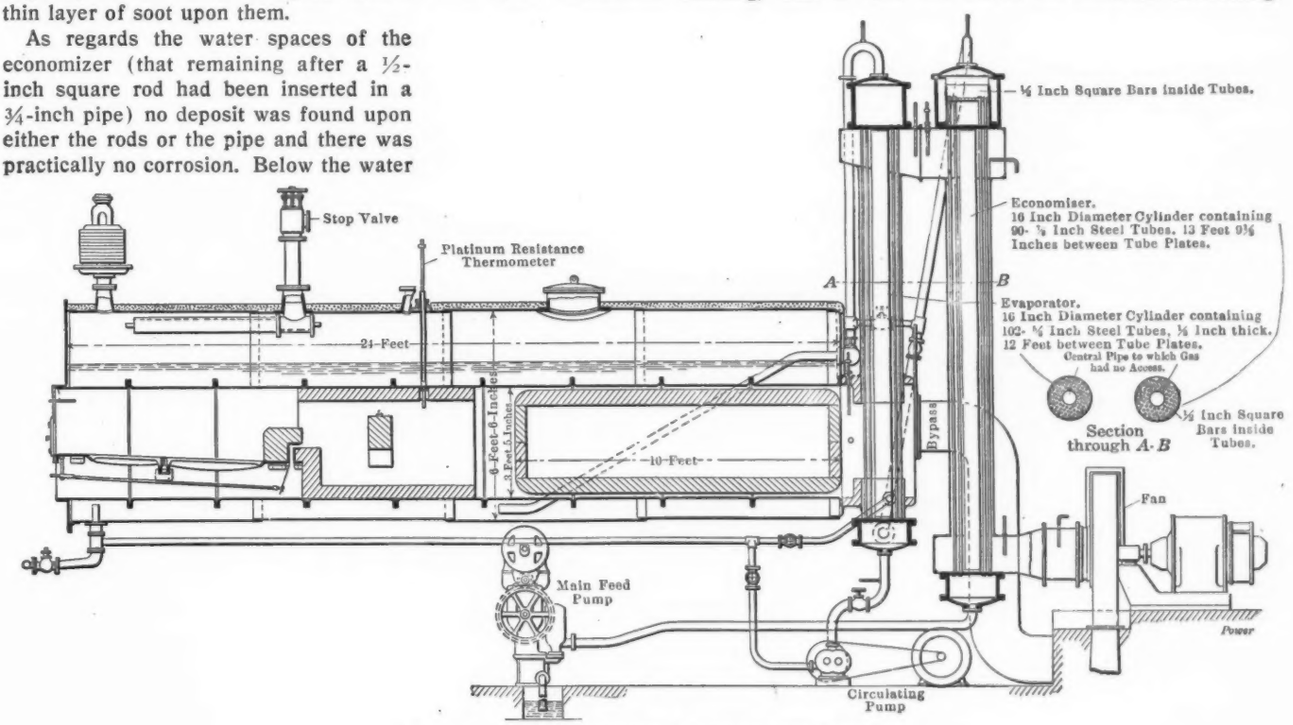


FIG. 2. SECTION THROUGH EXPERIMENTAL BOILER

Petroleum Competition

The Royal Dutch Shell group, according to the *Daily Consular and Trade Reports,* has entered into competition with the Standard Oil Company and is placing oil in France, and, it is reported here, has also determined to sell benzine in the United States, and four big tank steamers carried cargoes of this commodity some time ago to Boston.

Heretofore the Dutch combination has disposed of its products in the vicinity of production, and consequently placed its oil on these markets at a very cheap rate. It will be another thing to transport oil 13,000 miles and face a great competitor in its home markets, but the Dutch group seem to believe that they have sufficiently developed to succeed in the wider field, and this makes the situation interesting.

Oil is very cheap at Singapore with the price under competition going slowly down from day to day, so that 14 cents would buy as much oil at the end of October as 20 cents would in August. The result of the bitter fight between the great oil interests in the Far East is a reduction of prices to such an extent that the Chinamen are laying in good stores at very low prices in hope of future profits, while the native consumers enjoy the luxury of plentiful light.

The Steam Turbine in Germany

By F. E. Junge and E. Heinrich

The thermodynamic efficiency as a measure of comparison of steam turbine economies and an outline of the development of the Allgemeine Elektricitäts Gesellschaft turbine.

Before entering into the details of the discussion it is necessary to agree upon a common measure of comparison. Formerly the thermodynamic efficiency was used exclusively, this being the ratio of the energy actually utilized to the energy theoretically available, in other words, the ratio of the theoretical steam consumption of an ideal engine to the actual steam consumption. Those German firms which build only the steam end of the unit, generally base their steam-consumption figures upon the actual work transmitted, measured at the coupling between the turbine and generator shafts. In most other cases, however, the thermodynamic efficiency includes the electrical output of the generator.

Let

H_o = Theoretical heat drop, that is, the amount of heat which is available in an ideal engine per pound, or kilogram, of steam introduced into the cycle (adiabatic expansion);

H_e and H_{el} = Available heat per pound of steam, corresponding respectively to the work delivered to the generator coupling, and the electrical output;

D_o and D'_o = Theoretical steam consumption per horsepower-hour and per kilowatt-hour, respectively;

D_e and D_{el} = Actual steam consumption per horsepower-hour and per kilowatt-hour, respectively;

η_e and η_{el} = Thermodynamic efficiency referred to the output delivered by the turbine and by the generator, respectively.

In accordance with the foregoing the following ratios may be expressed:

$$\eta_e = \frac{H_e}{H_o} = \frac{D_o}{D_e} \qquad (14)$$

$$\eta_{el} = \frac{H_{el}}{H_o} = \frac{D'_o}{D_{el}} \qquad (15)$$

and if η_g represents the efficiency of the generator, then

$$\eta_{el} = \eta_g \times \eta_e$$

When making an efficiency test of a steam turbine, the values D_e and D_{el} are found by the test, the amount H_o being taken either from the Mollier or the Stodola steam tables. In this connection it should be noted that one metric horsepower-hour = 75 meter-kilograms per hour = 632 French units = 2510 B.t.u. per hour, and one kilowatt-hour = 632 ÷ 0.736 = 860 French units per hour = 3410 B.t.u.

In one kilogram of steam only H_o heat units are available; therefore,

$$D_o = \frac{632}{H_o} \text{ kilograms}$$

of steam are theoretically required in order to produce one horsepower-hour. Similarly,

$$D'_o = \frac{860}{H_o} \text{ kilograms}$$

is the theoretical steam consumption per kilowatt-hour. Furthermore, expressed in French units,

$$\eta_e = \frac{632}{D_e H_o} \qquad (16)$$

$$\eta_{el} = \frac{860}{D_{el} H_o} \qquad (17)$$

or in English units,

$$\eta_e = \frac{2510}{D_e H_o} \qquad (16a)$$

$$\eta_{el} = \frac{3410}{D_{el} H_o} \qquad (17a)$$

The comparison of two steam turbines on the foregoing basis alone is not free from objections and needs supplementary data. For the economic efficiency of steam turbines the ratio of the circumferential velocity of the blades to the jet velocity is essential. For a single stage the most favorable value of this ratio is, theoretically, 0.5, but on account of the losses which occur, this is reduced in practice to 0.4 or 0.45. Considering two turbines of the same type and having the same number of stages, one working with high superheat and high vacuum, and the other with a lesser degree of superheat and vacuum, this ratio will be considerably smaller with the former than with the latter, because the jet velocity is higher in the first case; therefore, the thermodynamic efficiency of the former will be inferior to that of the latter, although the steam consumption of the former is superior on account of the additional energy available. Besides the influence of this ratio upon the thermodynamic efficiency, constructive features are apt to affect the efficiency with a high heat drop. With a high vacuum the specific volume of steam grows to such an extent that the cross-sectional areas through the last stages and the length of blades cannot be enlarged so as to utilize the heat drop with the best possible efficiency; hence it is useless to go below a certain vacuum. Furthermore, the high-pressure part of turbines built upon the reaction principle is not capable of safely withstanding high working temperatures. If such turbines are destined to work with high temperatures the clearances between the fixed and the rotating parts must be considerably larger than when the working temperature of the turbine is low; hence the leakage losses increase and the thermodynamic efficiency decreases. Summing up, it may be said that the thermodynamic efficiency alone does not give conclusive evidence of the all-round economy of a turbine, but that the rate of energy drop which is utilized in the turbine must be taken into account.

The A. E. G. Steam Turbine

The steam-turbine factory of the Allgemeine Elektricitäts Gesellschaft, in Berlin, is the largest concern of its kind in Germany, employing more than 3000 workmen who are exclusively engaged in this specialty. On October 1, 1910, the total number of Allgemeine Elektricitäts Gesellschaft turbines built and ordered was 1339, representing a total capacity of 1,514,418 horsepower, and prior to 1902 the company had not taken up the manufacture of steam turbines. There were at that time two systems on the market which had given fair results and had proved their usefulness for general power work even in large units; these were the Parsons and the Curtis types. The De Laval turbine, which was to be found in nearly all markets on the continent, could not be used as a model for the manufacture of large steam turbines, on account of its limitations in capacity, it being incapable of producing, economically, greater outputs than 300 horsepower. Therefore the Allgemeine Elektricitäts Gesellschaft adopted an entirely novel system, known under the name of the Riedler-Stumpf turbine. The basic idea was to build a turbine wheel which could utilize the whole energy of the steam in a single stage, at speeds which were to remain within the limits of direct generator drive. Tangential impinging of the steam upon the blades, which were milled with a cutter from the solid wheel-disk, was a special constructive feature of this type; and for low speeds and heavy loads, velocity staging and, when necessary, pressure stag-

ing were provided. Although this system is no longer on the market, it possesses historical value, representing the attempt to utilize the single-stage principle for high capacities without having recourse to transmission gearing. The highest possible number of revolutions for turbines driving electric generators—at 50 cycles, such as is used in Germany—is 3000 revolutions per minute, for a generator having two poles. In order to obtain an economic ratio of circumferential velocity to steam velocity, which is essential for steam economy, very large wheel diameters had to be adopted.

Fig. 19 shows a wheel 6.57 feet in diameter, built for 3000 revolutions per minute, corresponding to a circumferential velocity of 314 meters per second or 1003 feet per second. Such extremely high speeds had never before been used in practice and, therefore, necessitated very careful construction of the wheel as well as the employment of first-class material. A high stress upon the material was allowed for and with the best material (nickel steel) a factor of safety of three to four was deemed sufficient. The guide blades for large capacities and low speeds, serving to conduct the steam back to the wheel to impinge upon it again, are shown in Fig. 20. A turbine of this type of 2000 horsepower capacity and single stage was erected at the Moabit central station of the Municipal Electric Works, of Berlin, and was subjected to a careful test in 1903 by F. Rötscher. (For details see "Research Work, Heft 50, Verein deutscher Ingenieure.")

In order to show the essential working conditions of the Riedler-Stumpf turbine the following figures are selected from the various tests:

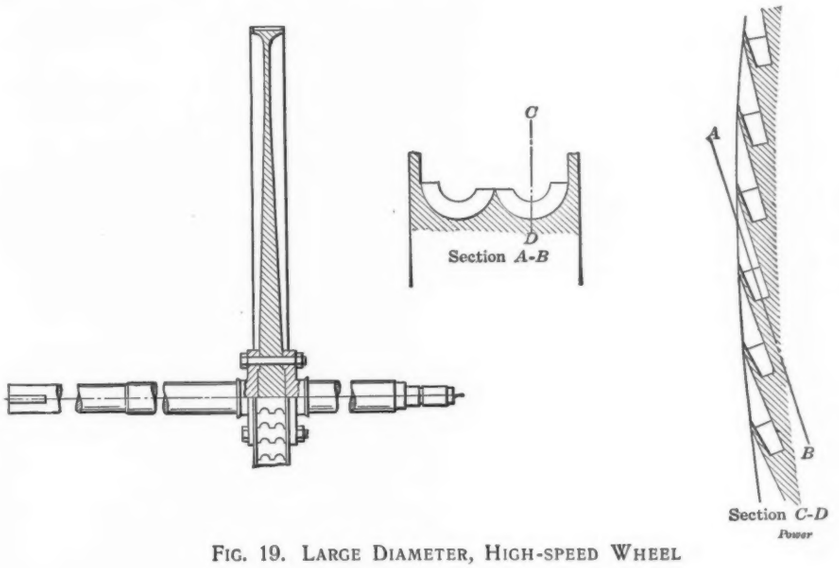


FIG. 19. LARGE DIAMETER, HIGH-SPEED WHEEL

Load, Kilowatts.	Steam Pressure. Kilograms per Square Centimeter.	Steam Pressure. Pounds per Square Inch.	Exhaust Pressure. Kilograms per Square Centim'er.	Exhaust Pressure. Pounds per Square Inch.	Steam Temperature. Degrees Centigrade.	Steam Temperature. Degrees Fahrenheit.	Steam Consumption. Kilograms per Kilowatt-hour.	Steam Consumption. Pounds per Kilowatt-hour.
1334	12.91	184	0.16	2.28	290	554	8.96	19.75

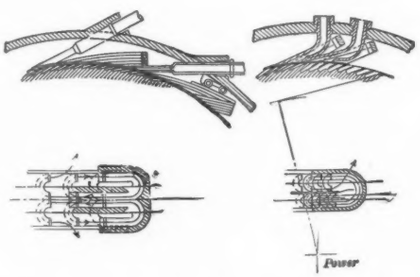


FIG. 20. GUIDE BLADES USED FOR LARGE CAPACITIES AND LOW SPEEDS

Therefore,

$$H_0 = 183\,WE$$

$$D_0' = \frac{860}{183} = 4.70$$

and

$$\eta_{el} = \frac{4.70}{8.96} = 0.525$$

Supposing η_g to be 91 per cent., then η_e would be 0.577 per cent.

The theoretical velocity of efflux at the nozzle is

$$c_0 = 91.2\sqrt{183} = 1240$$

meters per second = 4070 feet per second. The actual velocity, assuming a coefficient of loss in the nozzle of $\phi = 0.93$, is

$$c_1 = 1150$$

meters per second = 3775 feet per second. This gives as the ratio of circumferential to efflux velocity,

$$\frac{u}{c_1} = \frac{314}{1150} = 0.282$$

These figures show at once the weakness of the single-stage type. The value 0.282 is far below the most favorable value of this ratio. But considerations of strength forbid further increasing the wheel diameter so as to attain better efficiencies. The number of revolutions is fixed. Moreover, the drop of 183 heat units is very small, on account of the bad vacuum; but a higher drop would only decrease the efficiency, even if the steam consumption were better. The losses in the nozzles and blade pockets were very high in this turbine.

It will be remembered from the preceding articles that with Rateau stages, efficiencies as high as 67 per cent. were attained, while in this case the corresponding figure (including all additional losses through bearing friction, conduction and radiation) is only 58 per cent.

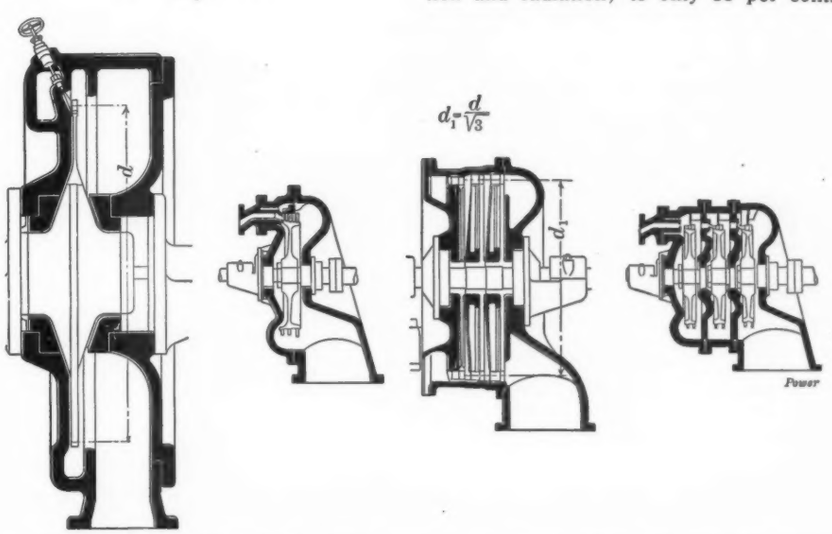


FIG. 21. RELATIVE SIZES OF FOUR TURBINES OF EQUAL CAPACITY AND SPEED

Therefore, the underlying idea of single-stage action for high capacities could not be realized in practice, so that the Allgemeine Elektricitäts Gesellschaft was forced to adopt another system. However, the attempt proved that circumferential velocities of from 300 to 400 meters per second can be safely used. Also, it might be mentioned that American designers of small turbines have readopted the characteristic blade form of the Riedler-Stumpf turbine.

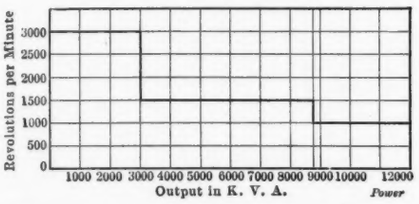


FIG. 22. LIMITS OF OUTPUT OF THREE-PHASE 50-CYCLE GENERATORS

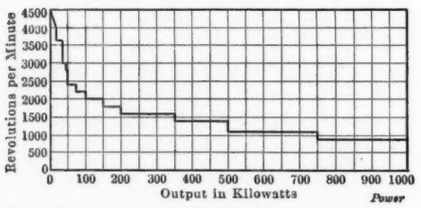


FIG. 23. VARIATION OF SPEED WITH LOAD IN DIRECT-CURRENT GENERATORS

As early as October, 1903, the Allgemeine Elektricitäts Gesellschaft had come to an agreement with the owners of the Curtis patent in America, especially with the General Electric Company, and by this agreement a sort of community of interests, scientific technical exchange, mutual exploitation of patents and a division of the markets, preventing the products of one firm from competing with those of the other in certain territories, was established. As regards the Curtis turbine, the German manufacturers preferred an independent course of construction, adopting the horizontal instead of the vertical type, the main reasons being that for the sake of steam economy in the larger types, the Rateau stages were adopted for the low-pressure portion, and as this necessitated a greater number of stages and therefore a greater total axial length of turbine, the vertical construction was rendered difficult.

Another problem to be considered was that of attendance. The same arguments which make the horizontal construction in steam engines, except in a few special cases, superior to the vertical type, hold true also for the turbine. The horizontal construction affords better accessibility to all parts and a better survey over the whole plant, especially easier control of bearing, governor, safety devices, etc. It also permits the machine to be dismantled and the interior exposed for inspection with much less trouble than with the vertical type. In view of the necessity of ease in dismantling, the pipe fittings, governing mechanism, etc., should be connected preferably to the lower part of the casing. The step bearing of the vertical type of turbine, which now seems to give satisfactory service, was regarded in the early days as a sensitive organism which was likely to give trouble. So it was deemed wiser in this respect by the builders to profit by the tests of Lasche

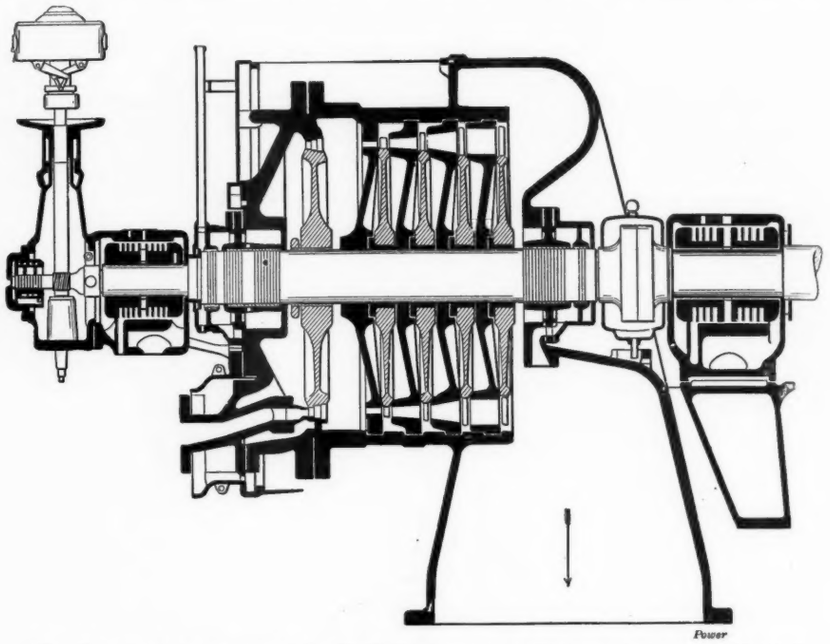


FIG. 25. A. E. G. TURBINE OF 3000 REVOLUTIONS PER MINUTE AND OUTPUTS GREATER THAN 1000 KILOWATTS

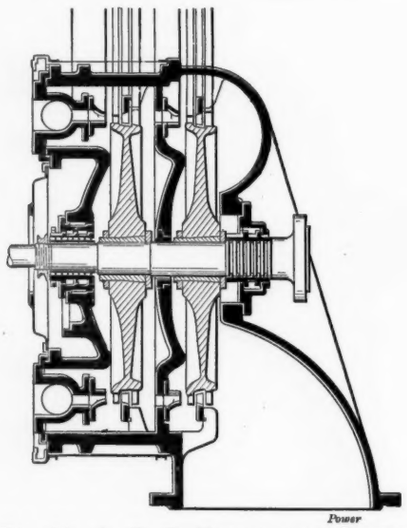


FIG. 24. A. E. G. TURBINE FOR SPEEDS OF 3000 REVOLUTIONS PER MINUTE AND LOADS UP TO 1000 KILOWATTS

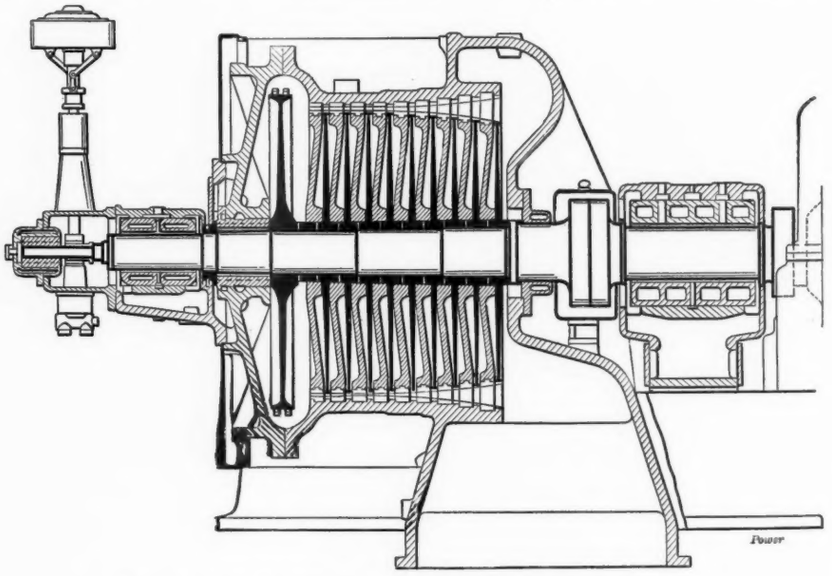


FIG. 26. A. E. G. TURBINE OF 1500 REVOLUTIONS PER MINUTE

and by the good results attained with horizontal bearings in the high-speed electric-railway trials.

As to bulk of plant, the floor space required is approximately the same for both types, if the condensing plant is taken into account (which has the same dimensions in both cases). Considering a turbine room containing several units, the centers between two units become somewhat greater with the vertical types; hence, the length of the plant is greater, while the width of the room will be smaller with vertical turbines than with horizontal ones. However, the hight of the room will be considerably greater for vertical than for horizontal turbines; hence it is safe to assume that the cost of the building for vertical units is greater than for horizontal units.

These and other considerations made it advisable for the Allgemeine Elektricitäts Gesellschaft, instead of copying the General Electric style of the Curtis type, to develop an entirely new and original form of horizontal turbine. With the style once agreed upon, the dimensions of turbines are dictated by three main considerations: First, reliability of operation; second, fuel economy; third, cost per horsepower. These three points of view do not exactly coincide. For instance, in reaction turbines safety of operation and economy stand in direct contrast, in so far as economy requires very small clearance between the guides and the rotating parts, in order to keep the leakage as small as possible, while reliability of operation demands larger clearances. On the other hand, with impulse turbines this does not hold true, and in designing these there is only a compromise between economy and cost.

It is obvious that turbines can be built cheaper if the specifications for steam consumption are less stringent. In one of the preceding discussions it was shown that, beginning at certain capacities (somewhere around 100 kilowatts) the Curtis and Rateau systems in the high-pressure portion are approximately on a par, as far as economy is concerned, there being only a slight superiority of the Rateau system, while, in the low-pressure portion, even for smaller outputs, Rateau wheels seem superior.

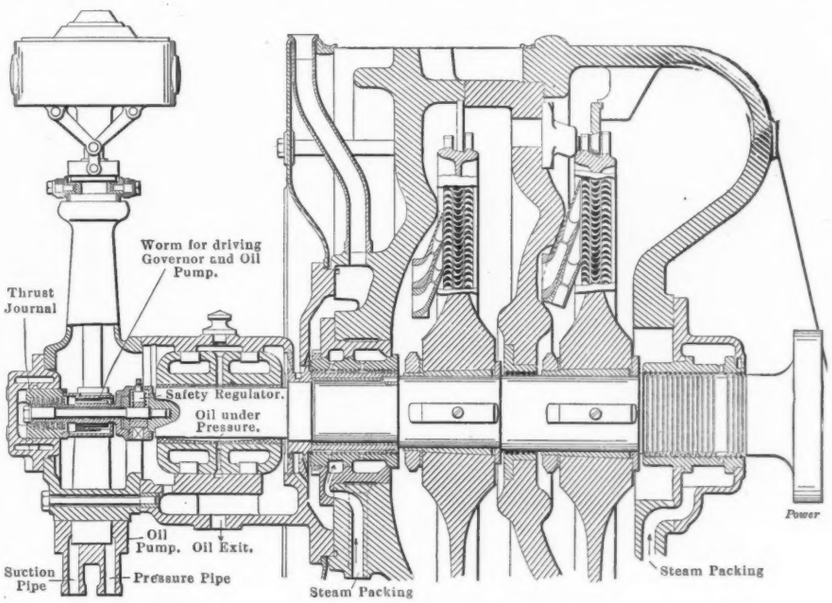


FIG. 27. SECTIONAL ELEVATION THROUGH A. E. G. TURBINE HAVING TWO PRESSURE STAGES TO ONE VELOCITY STAGE

A common feature of all Allgemeine Elektricitäts Gesellschaft turbines, regardless of capacity, is the employment of the Curtis wheel in the high-pressure portion. Experience leads us to believe that for very large capacities the Rateau action principle is superior whenever a high economy is to be attained, although the building cost is higher. For medium outputs of from 700 to 1000 kilowatts, the combined Curtis and Rateau turbine seems the more favorable. For very small capacities, of about 300 horsepower, the Curtis principle (wheels having two rows of blades) is preferable, especially if low speeds are desired for driving direct-current generators. Another point of division lies in the change from wheels having two to wheels having three rows of blades.

One of the problems which the Allgemeine Elektricitäts Gesellschaft had to solve is indicated in Fig. 21, which represents the utilization of a certain heat drop through four turbines of equal capacity and equal speed, and affords an illustration of the size and proportions of these turbines. There will be a certain (very low) capacity for which the efficiencies of the four are equal.

The number of revolutions, or the maximum output for a certain speed, is, as a rule, not determined by the turbine but by the generator. The rotor of the generator is a much more complicated mechanism as regards strength and dynamic conditions than are the rotating wheels of the turbine. The former is an unhomogeneous part, containing besides the iron of the shaft and the iron of the magnetic field, copper and isolating materials, which in the course of operation are subjected to dislocation, necessitating careful and repeated balancing and careful treatment.

Fig. 22 shows the limits of output for 50-cycle three-phase generators at the respective speeds of 3000, 1500 and 1000 revolutions per minute. The units running at 3000 revolutions per minute are built up to the limit of 3000 kilovolt-amperes. The limit of the 1500-revolutions per min-

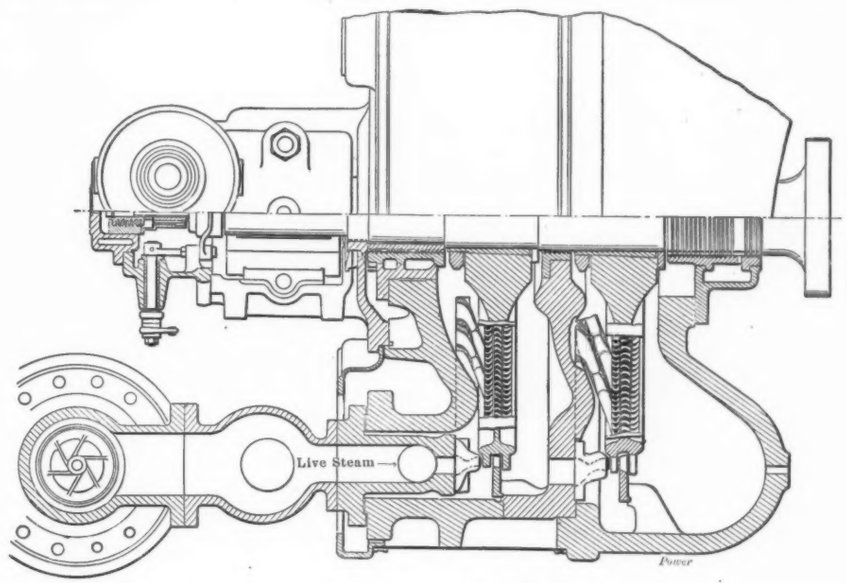


FIG. 28. SECTIONAL PLAN OF A. E. G. TURBINE

ute type lies at 8800, and that of the 1000-revolutions per minute type at 12,000 kilovolt-amperes. The capacities at high speeds increase year by year. In 1905 it was considered a risk to build a generator of 1000 kilowatts capacity running at speeds of 3000 revolutions per minute; today they are built up to 3000 kilowatts for the same speed. Considering that the specifications and guarantees are becoming more stringent year by year, whereby larger and larger wheel diameters are made necessary, and that higher vacuums are being employed, whereby the blades of the last wheels are subjected to heavy stresses, it goes without saying that designers are forced to approach very close to the limit of safe load.

In the Riedler-Stumpf turbine a wheel of 2000 millimeters, or approximately 79 inches diameter, running at 3000 revolutions per minute, was possible only by avoiding the employment of separate blades set in the rim, using instead, pockets milled in the rim. But in the case under consideration we have to deal with inserted blades of considerable length, exercising great additional centrifugal force on the circumference of the wheel.

Direct-current generators afford greater elasticity of speed but have a very sensitive makeup, the collector and the brushes militating against building direct-current generators beyond outputs of 1000 kilowatts. Fig. 23 shows how the normal speeds of direct-current generators vary with the change of load. It is seen that driving direct-current generators requires a greater variety of turbine types than driving three-phase generators. Comparatively small outputs, such as 600 kilowatts, are to be attained at 1200 revolutions per minute. Figs. 24 to 26 show the normal construction of the Allgemeine Elektricitäts Gesellschaft turbine in its various characteristic forms. Fig. 24 is the 3000-revolutions per minute type for outputs below and up to 1000 kilowatts, having the Curtis principle with two pressure stages to one velocity stage each. For higher outputs than 1000 kilowatts at 3000 revolutions per minute the action wheel in the low-pressure part is replaced by four or five Rateau wheels; see Fig. 25. The same holds true for the 1500-revolutions per minute type with the difference, however, that from nine to twelve Rateau wheels are employed in the low-pressure part, as shown in Fig. 26. Figs. 27 and 28 show the first named type of turbine, 3000 revolutions per minute up to 1000 kilowatts, in sectional elevation and plan with details of design to be discussed later.

The Mason Mechanical Laboratory

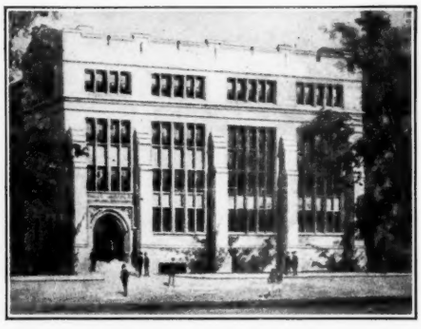
A three story building, 85 by 200 feet, donated to the Sheffield Scientific School of Yale University. The entire space will be devoted to laboratory work; no recitation or drawing rooms.

The accompanying illustrations show the new mechanical-engineering laboratory which is now being built for the Sheffield Scientific School, Yale University, New Haven, Conn. The funds for this laboratory were given to the Sheffield trustees by two graduates of the school, George Grant Mason, of New York City, and his brother, William Smith Mason, of Evanston, Ill., both of the class of 1888.

Work on the building is now in progress and the contract calls for its completion in the early summer of 1911. The frontage is about 85 feet and its length 200 feet. The architect, Charles C. Haight, of New York City, has worked out a very pleasing design, as Fig. 1 will testify. The long windows at the right are at the end of the testing floor, above which is a clear head room of 35 feet; at the left the smaller windows indicate the location of the main gallery and the mezzanine floors—which are possible on this side of the building throughout a greater part of its length. The building will have three stories above the basement. The front rectangle will be of Indiana limestone, and the extension will be of brick, with suitable stone trimmings. The entrance from Temple street will be sufficiently large for the admission of a team so that heavy pieces of machinery may be delivered directly under the traveling electric crane which will extend the entire length of the building with a span of about 40 feet.

An examination of the floor plans will indicate, in a general way, what is to be the distribution of the equipment and the arrangement of the rooms for offices, lectures, computation, research and general experimental work. No provision for recitation or drawing rooms has been made in the building—the entire space being devoted to instruction in experimental work for undergraduates and for research work in engineering science for graduate students, research fellows and special investigators.

The main floor of the laboratory will contain the larger part of the equipment—especially the heavy pieces of machinery—such as machines for testing the strength of materials, steam engines and gas engines of various types, steam turbines, steam and centrifugal pumps, air compressors and refrigerating machinery, together with the auxiliary equipment of condensers, fans, electric motors, scales, tanks and smaller appliances for testing. This equipment will be erected under the crane. The units will, for the most part, be small and self-contained. A large part of the floor under the crane will consist of heavy concrete, suitably arranged with parallel grooves for bolting the equipment at any point. The steam, water, gas and other pipes will be run in the basement below, provision being made for their extension to the testing floors through a series of auxiliary tunnels which occur at frequent intervals. All testing-floor areas are suitably drained so that an abundance of water may be used whenever it is necessary or desirable.



MASON LABORATORY OF MECHANICAL ENGINEERING

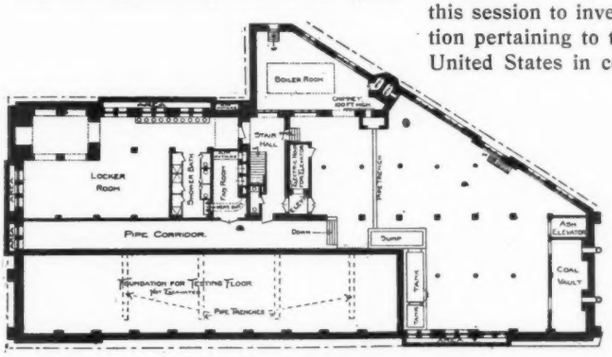
In the front basement will be located the toilet and locker rooms. There are several shower baths. The boiler-room extension provides for the heating and power boilers. An auxiliary power plant, both steam and gas-electric, will be located near the boiler room. Tanks of concrete will provide water storage and a large sump below the level of the street drains will receive all drainage not otherwise provided for. The sump will be automatically emptied by an electric centrifugal pump. Coal-storage bins and ash-elevating machinery will be located at the Temple street end of the building. Access to the basement is provided for heavy machinery through a large trap door suitably located under the crane, as well as by the electric elevator which connects all floors.

No attempt has been made to provide mechanical ventilation for any of the rooms except the lecture room and the computing room directly above it. For these rooms the fresh-air supply will be furnished through the ducts as shown. A gravity circulation will frequently be sufficient to provide the ventilation required, but a motor-driven fan will be installed to augment the natural circulation at such times as it may be necessary.

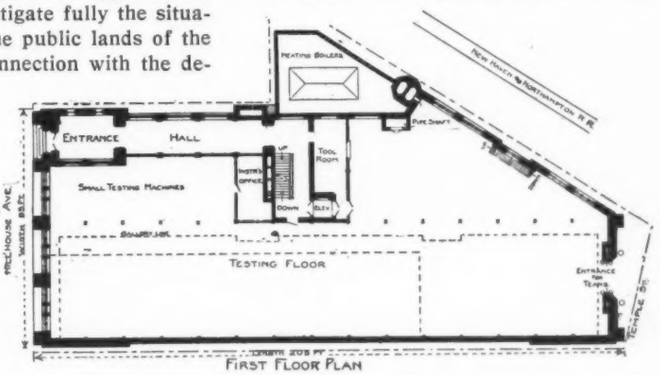
The gallery floor contains considerable space available for lighter machinery, several small offices and the general

lecture room, with a seating capacity for 150. There are two landing platforms on this floor so that the traveling crane may deliver heavy pieces under a trolley rail extending through the lecture room or across the open floor space at the east end of the laboratory.

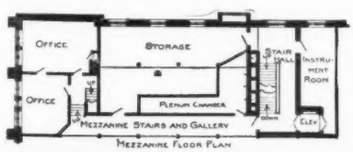
The distribution and use of the space on the third floor are sufficiently evident from an inspection of the plan of that floor. The room devoted to mechanical technology will be used as a laboratory for instruction in machine design, machine construction and mechanism. It is planned to have, not a museum, but an exhibition of modern machines of special and complex design. Power will be available for the operation of such machines as may be placed here for study. In many instances the machines may be on exhibition for only a short time and a representative of the company furnishing the machine may be asked to demonstrate its working.



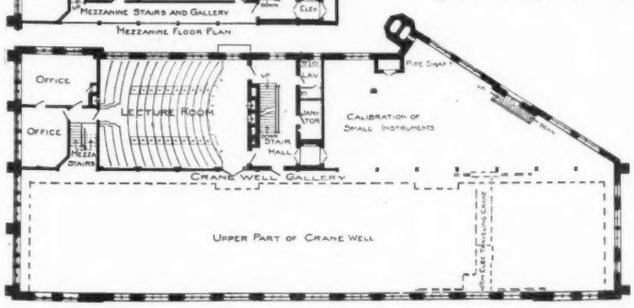
BASEMENT PLAN



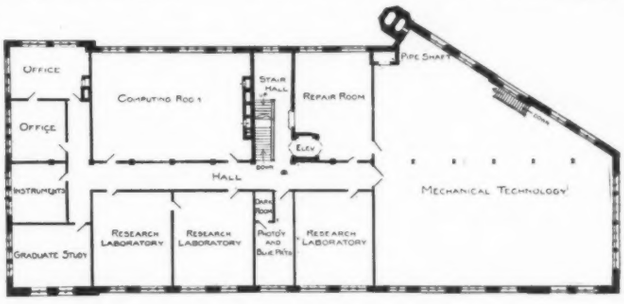
FIRST FLOOR PLAN



MEZZANINE FLOOR PLAN



SECOND FLOOR PLAN



THIRD FLOOR PLAN

The completion of this laboratory will give to the Sheffield Scientific School many needed facilities available for all its engineering departments, and it will give to mechanical engineering what the Hammond laboratory gives to the students of mining engineering.

It will be remembered that the gift for this laboratory included $200,000 for the building and its equipment, and $50,000 for its endowment.

The general contractors for the construction of the building are P. C. Stuart & Co., New York City.

Congress Urged to Investigate Water Power Question

At the January 12 meeting of the executive committee of the National Electric Light Association, a set of resolutions were adopted urging that a joint commission of Congress be appointed at this session to investigate fully the situation pertaining to the public lands of the United States in connection with the development of water powers. The association represents about two billions of investment in central stations for electric light and power and the apparatus they employ, with 100,000 employees, and includes within its ranks 90 per cent. of the investment and capacity for public service thus represented. There are already nearly 1000 central stations in this country using water powers, but under the present conditions that have tied up such development very few new water-power plants can be undertaken, and the result is that for lack of such utilization of such water power, the consumption of coal and other fuel goes on at a rapidly increasing rate. It is to relieve this deadlock that Congress is invited to investigate fully at once all the aspects of the matter, with the idea that a great many communities, particularly in the West, which are seeking to advance the development of unused water-power sites, may be enabled to gratify their natural wishes in this respect.

The resolution reads as follows:

"Whereas the condition of the laws and regulations relating to the public lands of the United States Government is so complicated, unsatisfactory and unsettled that the financing and commercial development of new enterprises in connection with public lands is rendered practically impossible; and

"Whereas the immediate development of the idle water powers of the nation is of importance to the whole people in that it brings to immediate use an indestructible natural resource that would be otherwise lost or idle and conserves coal, oil, gas and other fuels that are limited in amount and subject to replacement; and

"Whereas the National Electric Light Association is particularly interested in the situation pertaining to public lands of the United States in connection with the development of water powers; and

"Whereas much of the difference of opinion upon the subject of water powers arises from the difficulty of obtaining a clear comprehension of all the facts:

"Now, therefore, be it

"Resolved: That this association does respectfully urge that a competent commission, composed of members of the Senate and House of Representatives of the United States, together with persons familiar with the financial and other practical aspects of the situation, be appointed with full authority to collect the evidence, and for that purpose to hold full and complete open hearings in different sections of the country; and be it further

"Resolved: That this association does respectfully urge that such commission be appointed at as early a date as possible to the end that its meetings may be held between the adjournment of the present session of Congress and the reassembling of the new Congress in the hope that such commission should report upon such reassembling and Congress be thereby enabled to take prompt action in the enactment of such laws as will permit the development of the natural resources of the country in such a manner as shall render them of the greatest possible use to all of the people."

Electrical Department

Especially conducted to be of interest and service to the men in charge of the electrical equipment

Hand Controllers for Multi-Speed Induction Motors

By R. H. Fenkhausen

The present article is devoted to a practical consideration of the principal types of apparatus now available for controlling the speed of induction motors. The motors themselves have already been explained in a previous article (June 9, 1908); the present article, therefore, is restricted to the controllers alone.

The controlling apparatus for any induction motor of the wound-rotor type provided with external resistance must consist of two separate and distinct devices; namely, a line switch, by which

Fig. 1. Simple Oil-break Starting Switch

the current supply to the stator windings may be cut off or on and, in the case of a reversing motor, reversed; and a drum controller by which the resistance in the rotor circuit may be varied to obtain different speeds in the motor.

When the secondary resistance is for starting duty only, a controller of the type shown in Fig. 1 will often fill all requirements. A knife switch, preferably of the oil-break type, is used to close and open the leads from the supply circuit to the stator or primary, and when reversal of the motor is desired, the switch may be double-throw.

Owing to the short duration of the starting period the resistance does not need to be of large capacity and is therefore inclosed within the same case with the drum controller, making a very compact outfit and one that requires the least possible labor to install, as all the connections between the controller and the resistance are permanent. For large motors an independent short-circuiting switch should be installed near the motor in order that the resistance of the collector rings, controller contacts and wiring will not cause too large a full-load slip in the rotor.

When the secondary resistance conductor is used for speed regulation, the resistance is in circuit at all times, and in order to obtain sufficient ventilation to keep the temperature rise within a safe

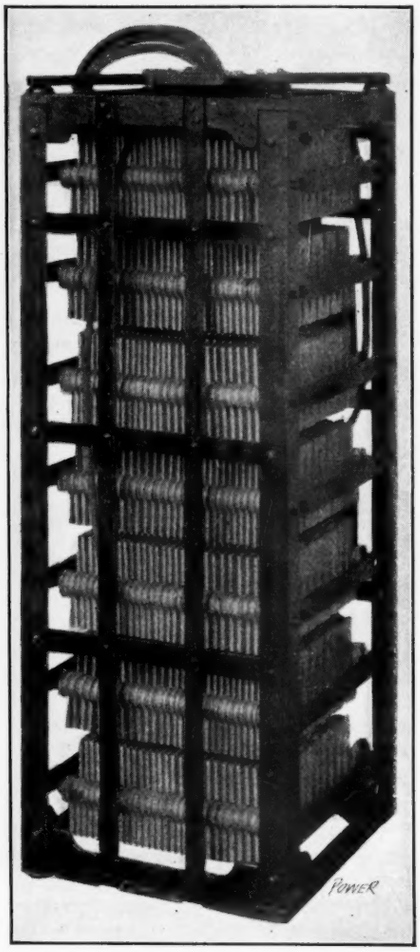


Fig. 2. Resistor Grids in Frame

limit, the resistance is usually mounted separate from the controller. Fig. 2 shows a set of resistance grids suitable for this service. Flexible cables are attached to the various taps, which connect to similarly numbered cables from the controller.

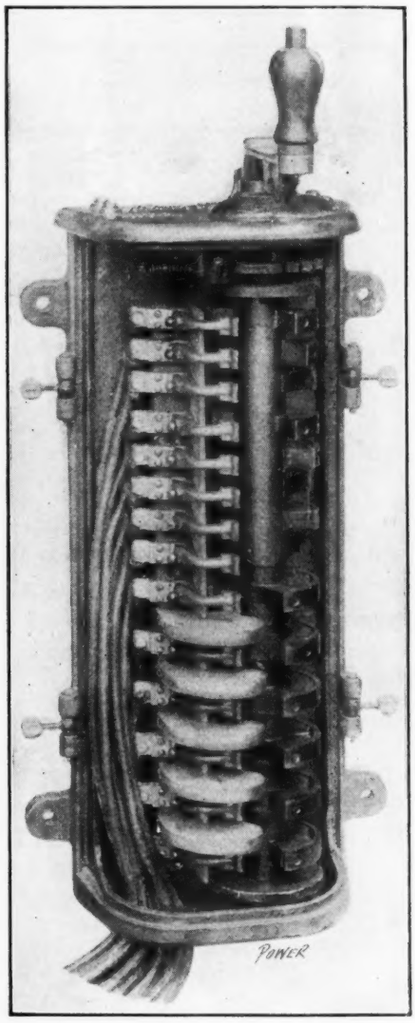


Fig. 3. Stator and Rotor Control on One Spindle

In a previous article attention was called to the fact that wound-rotor motors equipped with independent primary and secondary switches were liable to damage by the line switch being closed by a careless operator when the secondary resistance was cut out. While separate switches are permissible for starting service only, for varying-speed service it is essential that the primary and secondary switches be mechanically interlocked. This is especially necessary where the motor is to

be frequently reversed. This mechanical interlocking may be accomplished in several ways. The simplest method is to mount the primary and secondary controlling drums on a common shaft, as shown in Fig. 3, and arrange the connections so that the stator circuit cannot be connected to the line except when all the rotor resistance is in circuit.

The principal objection to this method is the unnecessary wear of the primary switch. After it is closed on the first notch, no further movement is necessary during the various speed changes until the motor is again stopped, but, as the primary and secondary switch drums are mounted on a common shaft, a corresponding movement of the primary switch

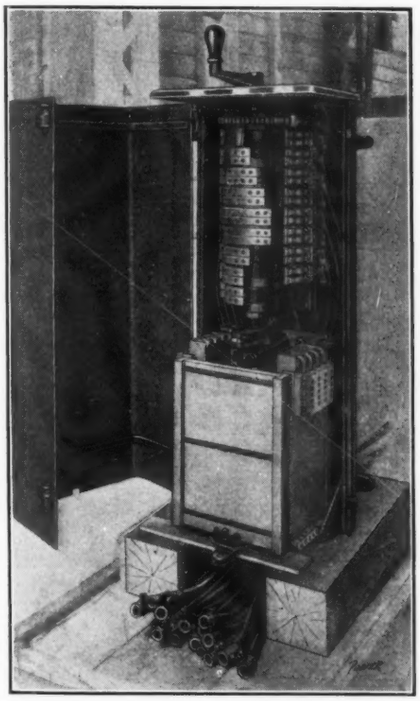


FIG. 4. SPEED CONTROLLER WITH CAM-OPERATED STATOR SWITCH

is made for every speed change made with the secondary drum. This not only results in unnecessary wear of the primary contacts, but increases the effort necessary to move the controller, owing to the extra number of fingers bearing on the drum. In large controllers this entails considerable additional exertion on the part of the operator. In order to get rid of these objectionable features, the primary switch is often so arranged that a cam on the operating shaft of the controller closes it for the desired direction of rotation when the controller lever is moved to the first notch and does not again move it until the controller is returned to the "off" position. Such a controller is illustrated in Fig. 4, and a detail of the reversing mechanism is shown in Fig. 5. The primary contacts are submerged in an oil tank to suppress the arc.

It is not desirable to carry high-voltage leads inside the controller case; for high-voltage motors, therefore, the controller is provided with an external oil switch operated by a lever projecting through the rear of the controller case, as shown in Fig. 6. The lever is operated on the

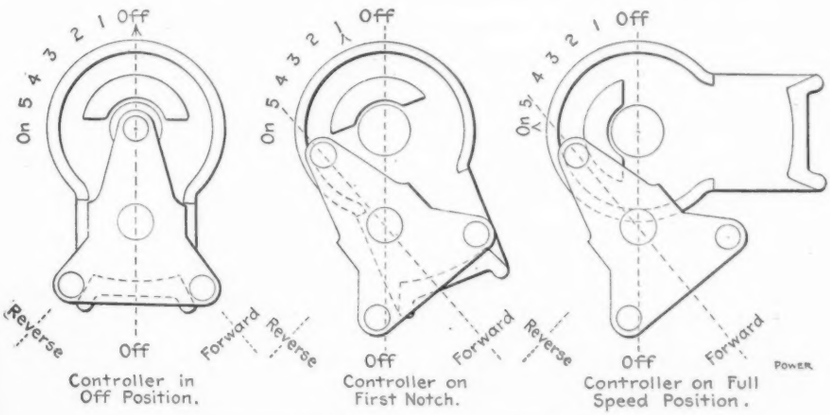


FIG. 5. REVERSING MECHANISM OF CONTROLLER IN FIG. 4

first notch by a cam on the controller shaft similar to that shown in Fig. 5. This arrangement makes it possible to adjust the secondary fingers and drum contacts without danger of a shock from exposed parts of the primary switch.

Controllers are made for both reversing and nonreversing service, the only difference being that on the nonreversing controller the "off" and full-speed positions are at opposite ends of the travel of the handle and the primary switch simply closes and breaks the main-line connections, whereas on the reversing controller the "off" position is in the center of the travel of the handle and the primary switch is arranged to reverse one phase of the primary leads when the controller handle is moved to the "reverse" side of the "off" position.

CONTROLLER REQUIREMENTS

Controllers and resistances are customarily supplied by the motor manufacturer, but in case the motor is an old one, or is bought of some company that does not make its own controlling apparatus, the following information must be supplied to the company furnishing the controller and resistance:

1. Number of phases, voltage, horsepower and frequency.
2. Secondary current per phase of rotor winding.
3. Secondary voltage or ratio of primary to secondary turns.
4. Kind of service: Continuous or intermittent at reduced speeds.

Even when all the apparatus is furnished by one maker it is desirable that the secondary current of the motor be known in order that the leads from the controller to the collector rings may be made of ample size. If this is neglected an objectionable increase in the full-load slip of the motor will result, with evil effects on both the efficiency and speed regulation at normal speed.

The secondary currents vary in motors of different manufacture, but the figures in Table 1 may be considered as fair averages for wound-rotor induction motors. This table also shows the difference in motor ratings for continuous and intermittent service.

As noted in a previous article, the rotors of motors designed for continuous operation at reduced speeds are made of high resistance and the secondary current

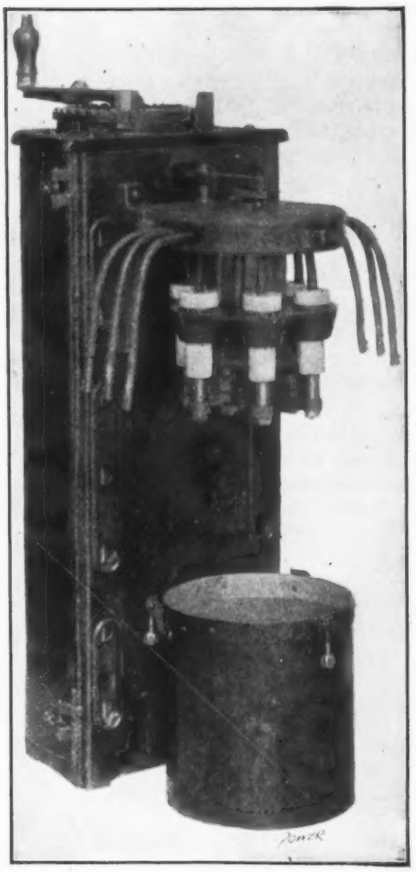


FIG. 6. STATOR SWITCH OPERATED BY LEVER FROM MAIN CONTROLLER

is small; motors designed to run mostly at full speed and only occasionally at reduced speed are equipped with low-resistance rotors, and the secondary current is relatively large. The resistance grids for the latter type of motor are necessarily quite large and for convenience are usually mounted in two or more frames; one such frame is shown in Fig. 7. The grids designed for the higher resistance motor are smaller and may be mounted all in one frame, as in Fig. 2. In cases where a regular multi-speed controller is used for starting duty only, the resistance grids carry current only for a short time and may be made proportionately smaller.

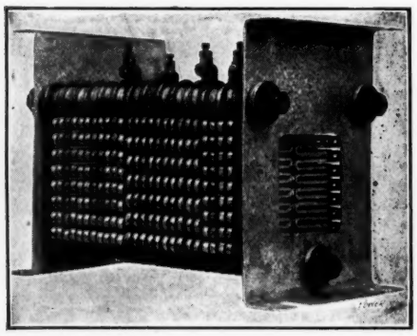


FIG. 7. HEAVY-DUTY RESISTOR GRIDS

There are two methods of varying the resistance in the rotor circuit. In the first method, the connections of which are shown in Fig. 9, resistance is cut out of each phase of the rotor in turn. This method is employed in the controller shown in Fig. 3, and, although it results in the rotor currents being out of balance on two speeds out of each three, this disadvantage is more than offset by the reduction in the number of controller contacts required for a given number of speeds, and the resultant saving in wiring and controller maintenance. In the second method resistance is cut out of all three phases of the rotor circuit simultaneously. This method is used on the controllers shown in Figs. 4 and 10. The connections for this method are illustrated in Fig. 8 and, although the rotor phases are kept in perfect balance, it is apparent from the drawing that the number of drum contacts is considerably greater than is required when the method shown in Fig. 9 is employed.

For elevator service a controller similar to the one shown in Fig. 10 is used. The primary switch is operated by the elevator rope and the secondary switch is operated by a spring which is compressed by the movement of the primary switch. This spring turns the drum against the retarding influence of a dashpot, and by adjustment of the dashpot the rate of movement of the secondary drum, and consequently the acceleration of the motor, may be regulated independently of the will of the operator.

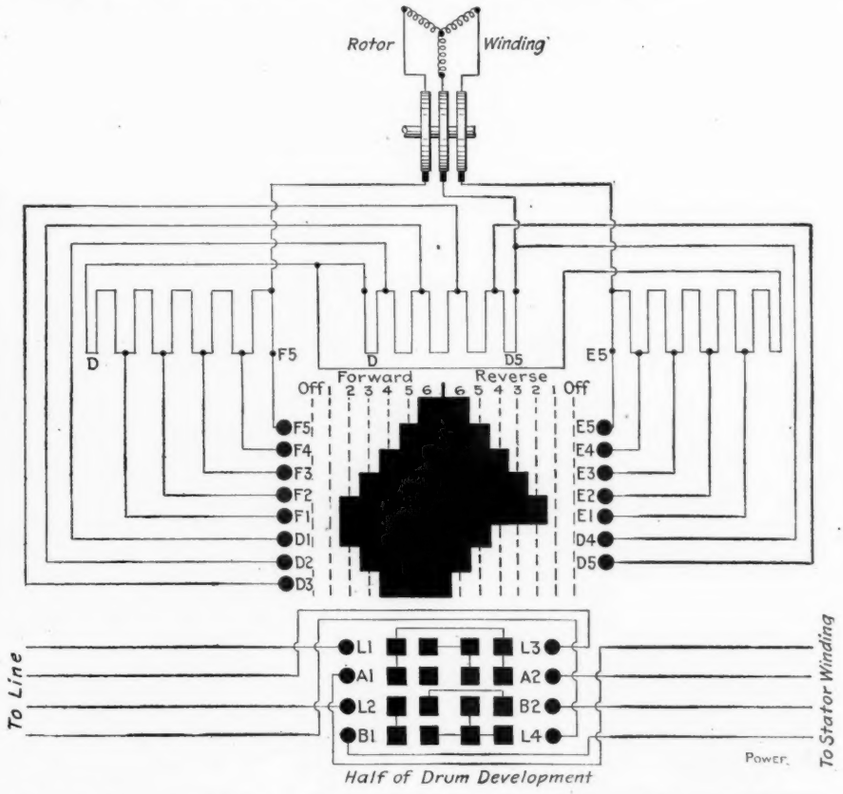


FIG. 8. CONTROLLER FOR CUTTING OUT ALL THREE RESISTORS SIMULTANEOUSLY

TABLE 1. DATA CONCERNING INDUCTION MOTORS OF THE WOUND-ROTOR TYPE FOR VARYING SPEED SERVICE; WITH ROTORS WOUND 3-PHASE FOR 60 CYCLES.

HORSEPOWER.		SPEED.		FULL-LOAD AMPERES PER PHASE (STATOR).				ROTOR AMPERES.
Continuous Rating.	Intermittent Rating.	Synchronous.	Full Load.	2-phase, 220 Volts.	3-phase, 220 Volts.	2-phase, 440 Volts.	3-phase, 440 Volts.	All Phases and Voltages.
5	7½	1200	1080	11.45	13.25	5.75	6.65	65
7½	11	1200	1080	17.20	19.85	8.60	9.95	71
10	15	1200	1100	22.65	26.20	11.35	13.10	78
15	22	1200	1120	33.20	38.40	16.60	19.20	93
20	30	1200	1105	43.75	50.75	21.85	25.35	155
25	37	1200	1115	54.80	63.40	27.45	31.70	154
35	52	900	830	80.20	92.90	40.15	46.45	175
50	75	900	840	107.15	123.60	53.50	61.80	190
75	112	720	690	164.00	189.50	82.00	94.70	225
75	112	514	495	164.00	189.50	82.00	94.70	180
100	150	720	675	214.05	247.20	107.00	123.00	225
110	165	450	430	235.10	271.30	117.50	135.10	250
150	225	600	575	326.50	377.75	163.25	188.00	286
150	225	450	435	326.50	377.75	163.25	188.00	250
200	300	600	580	427.00	493.00	213.00	225.00	287

"CASCADE" CONNECTION

The greatest disadvantages of the wound-rotor type of induction motor are its inability to maintain constant speed when the load varies, except at full speed, and its poor efficiency when running at reduced speeds. These difficulties cannot be overcome by any commercial control method when one motor is used, but where two motors are connected to the same load, two or more constant and efficient running speeds may be obtained by the use of the so called "cascade" connection. Fig. 11 shows the simplest form of this connection. The rotor circuits of the two motors are connected and the stator of one motor is short-circuited. If the stator of the other motor be connected to the line, both motors will run at a speed corresponding to that of one motor having as many magnetic poles as both of the two motors. The motors shown have equal numbers of poles, so the resultant speed will be one-half that of either one operating alone. This speed will be maintained practically constant under widely varying loads, and the efficiency will be quite high. This control method is similar in principle to the series-parallel method of direct-current control, and, in common with it, requires that both motors

be rigidly connected to the load, either by direct coupling or gearing. If this is neglected, one of the motors may run up to full speed and the other one stop the first time the division of load between the motors is disturbed.

This method of control may be extended by the use of two motors having a different number of poles, in which case four constant running speeds are obtained. For example, if an 8-pole and a 12-pole motor are installed, the following speeds are obtainable on a 25-cycle circuit:

	Revolutions per Minute.
1. Motors in direct "cascade"....	150
2. 12-pole motor alone.....	250
3. 8-pole motor alone.....	375
4. Motors in differential "cascade"	750

In differential cascade the motors are connected for opposite directions of rotation and the resultant speed is equal to that of one motor having a number of poles equal to the *difference* between the numbers of poles in the two motors.

The "cascade" method of control is quite expensive to install, as a double motor investment is required owing to the fact that either one motor alone is in use or else the two motors are working at greatly reduced capacity.

For the control of high-resistance squirrel-cage motors in which the speed is regulated by varying the primary voltage, a controller of the type shown in Fig. 12 is used in connection with an autotransformer. There are twice as many contact segments as there are autotransformer taps, and every other segment is connected to a resistance in such a way that the controller brush in passing from one autotransformer connection to the next one, never rests upon two segments connected to different taps at the same time, but always bridges one "live" segment and one resistance segment in such a way that there is always a dead resistance in circuit while taps of different voltage are connected. This obviates the necessity of "killing" the motor while passing from one segment to another.

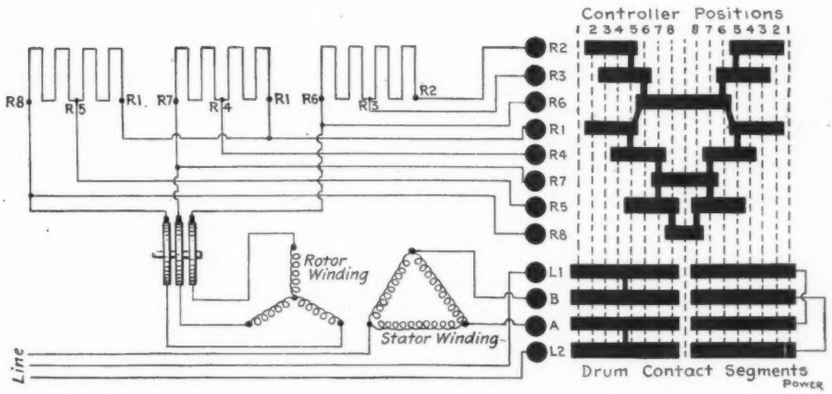


FIG. 9. CONTROLLER FOR CUTTING OUT THE RESISTORS SUCCESSIVELY

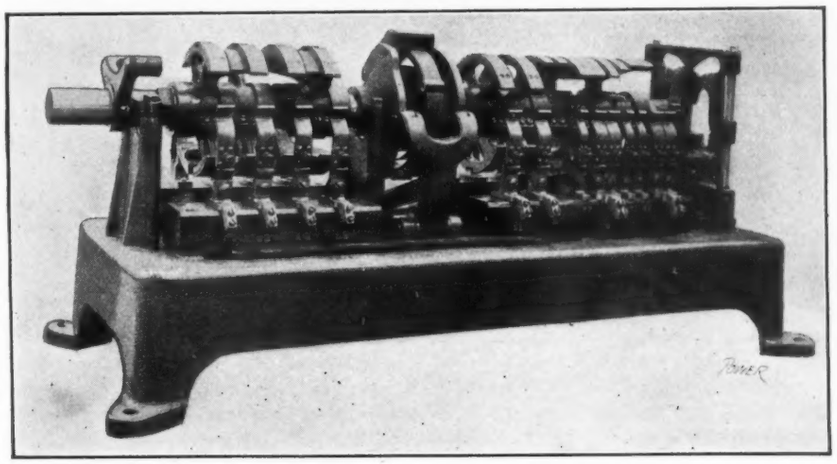


FIG. 10. HORIZONTAL CONTROLLER FOR ELEVATOR SERVICE

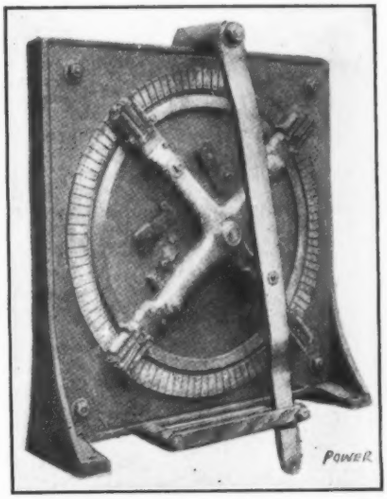


FIG. 12. CONTACT PLATE FOR AUTOTRANSFORMER CONTROL

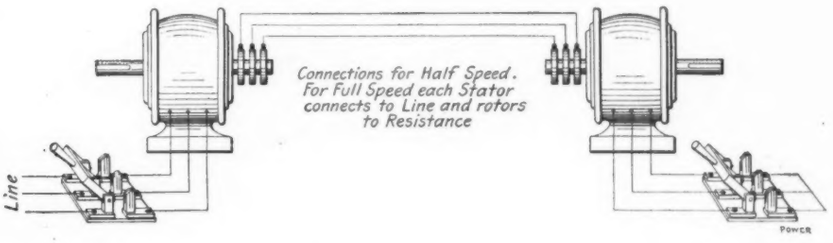


FIG. 11. CONNECTIONS FOR "CASCADE" CONTROL

LETTERS

Line Disturbance by an Induction Motor

In a recent number, Louis J. Gorilla asks why an induction motor makes the lamps flicker. I will cite an experience that may help him.

I am operating a 150-horsepower induction motor equipped with a starting resistance mounted on the rotor. I was troubled with a brush eating into the short-circuiting ring, and upon taking the bolt out I found that it was loose where it screwed into the rotor; it was also a loose fit in the spool. The bolt was wrapped with shellacked paper to fit the spool and screwed firmly into the rotor, and the machine has been running two years without giving any more trouble.

Tustin, Cal. W. N. GULICK.

While removing a broken set screw, it was nearly drilled out, when the drill refused to cut. Applying more pressure and sharpening the drill did not help matters. The puzzle was solved when the point of the set screw was found on the end of the drill, with which it was revolving.

Gas Power Department

Everything worth while in the gas engine and producer industry will be treated here in a way that can be of use to practical men

Reducing Motion for Gas Engine Indicators

By Robert G. Brown

The attempt to apply to a gas engine of the inclosed type an indicator reducing motion usually develops several difficulties. To convert the rotary motion of the flywheel and shaft into a reciprocating motion corresponding to the movement of the piston and of a length that will give a good indicator diagram, generally requires a crank and connecting rod of a small scale but of the same ratio as those of the main engine. Such an apparatus has several joints which are subject to wear and lost motion; and if the engine is a large one a special arrangement will probably have to be attached to the outside of the flywheel to

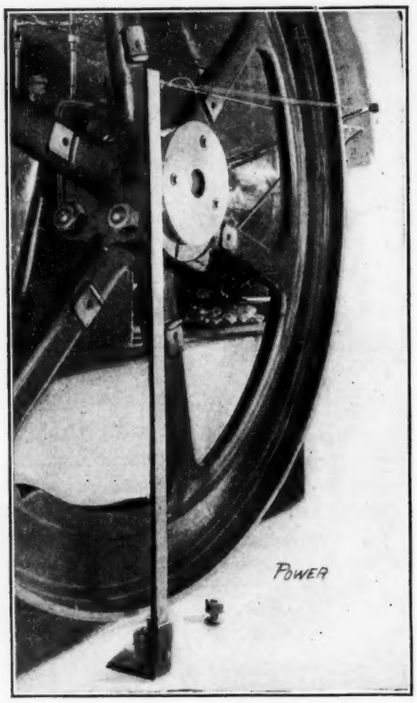


Fig. 1. Eccentric and Oscillating Bar

carry this gear. The custom of using a pin in the end of the shaft to which is attached the indicator cord is inaccurate mechanically and is not easy to connect to when running at 300 revolutions or over.

In the effort to overcome the difficulties mentioned, the cam reducing motion here illustrated was designed. The cam is most simple to make—only requiring a simple turning operation in a lathe. It is attached with two or three cap screws to the end of the shaft or the hub of the flywheel. In some cases it may be necessary to bore it large and slip it over the shaft.

Fig. 1 shows a reducing motion of this kind applied to a Fairbanks-Morse Type L producer-gas engine. The flywheel is six feet in diameter. The cam plate bolted to the hub of the flywheel, and a cherry-wood bar, hinged to a floor bolt, constitute all the parts. The cam has a V-shaped groove around its edge and a roller on the wooden bar runs in this groove. Unfortunately the indicator could not be shown from the viewpoint of Fig. 1. Fig. 2 is a view looking down on the engine and this shows the location of the indicator at the engine cylinder. The guide pulley for the lead is supported by a tripod of light metal bars.

The indicator lead should be of wire for such a length, and sharp turns should be avoided. The wire should not be carried around the small pulley and drum of the indicator, because it will soon break; a short piece of cord is attached to the end of the wire for this purpose. The wire must run in a direction at right angles to the wooden bar when the latter is midway of its travel. The lead can be hooked and unhooked in any convenient way, to suit the ideas of the operator. The coil spring attached to the end of the bar serves to make the bar follow the cam, thereby relieving the indicator drum spring of this work; on engines which run at less than 200 revolutions per minute, this spring will not be necessary.

A suitable length of diagram can be had by attaching to different places on the bar. The cam itself gives a perfectly accurate motion, but the use of the oscillating bar introduces a slight theoretical error. However, by making it as long and light as possible, the error cannot be detected.

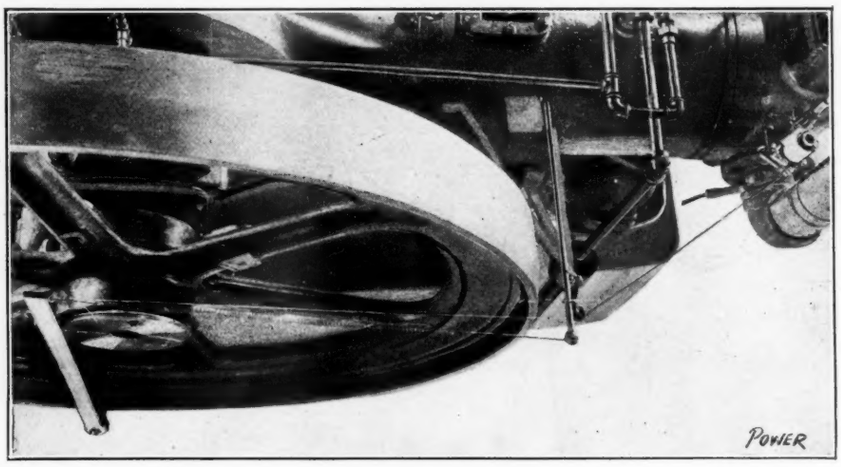


Fig. 2. Looking Down on Engine Equipped with Reducing Motion

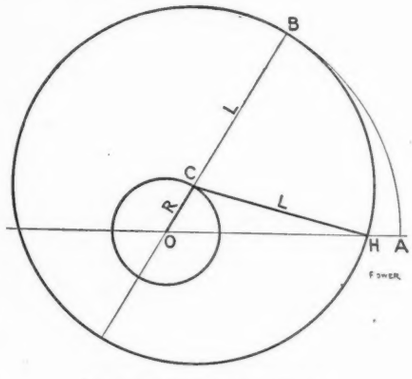


Fig. 3. Graphical Proof

The correctness of the cam motion can be proved mathematically, but the graphical one given in Fig. 3 is sufficient. The lines *R* and *L* represent to scale the

lengths and positions of the crank and connecting rod of the engine; *L* also represents, to a different scale, the radius of the cam circle. The center of the shaft is at *O* and *C* is the center of the cam disk, *O C* being the amount the cam is set eccentric. Since *C* is the center of the cam circle, *C H* = *C B* and *B O* = *O A*. Therefore, when the cam and the crank have moved through any angle, such as *B O H*, the roller has traveled the distance *A H*, which is evidently proportional to the motion of the engine piston. The curve *B A* is the path followed by the point *B* during the travel from *B* to *A*.

In laying out the cam for a reducing motion of this kind for a given engine, all that is necessary is to find the ratio of crank to connecting-rod length for that engine. For example, if this is 1 to 5, the cam may be made 5 inches radius and its center set 1 inch off the center of the shaft in line with the crank axis; then it will give the correct motion and the length of the indicator card may be chosen as explained above.

Gas Engine Equipment

By H. W. Jones

As my whole interest in the gas-engine industry is to improve the standing and applicability of the engine, I feel free to discuss the above topic without being accused of "knocking."

I wish to suggest, not alone on the basis of my own experience but on that of others, that it is about time to consider the difference between the cost and the value of the auxiliary equipment of gas engines and, further, to consider what it really should mean when a gas or gasolene engine is installed *complete*. From my price book, which gives the cost of various makes of gas engines, I find that an engine of 20 horsepower can be sold "complete" at a fair profit for $650, and the same engine can also be sold "complete" for $750, keeping the profit exactly the same, the difference in the cost being $100. It all depends on what "complete" means. With some builders the selling price includes a set of engineer's oil cans, also a full set of wrenches, foundation bolts and special washers, an ignition battery, spark coil and switch.

Now, the price of these extras and auxiliaries may be $2.50, or it may be $22.50, and the $22.50 outfit may be the cheaper. The cutoff switch in the ignition circuit may cost $1.80 per dozen or $1.80 each; a set of six battery cells can cost $1.50 or $18; a spark coil for a make-and-break system can cost 50 cents or $3, while the coil of a jump-spark system can be bought for either $2 or $10, or almost any intermediate figure. Some jump-spark coils are very expensive at $4, while others are cheap at $14.

When a man buys a gas engine he seldom considers or knows anything about these points. He may be a master mechanic of the very top grade and yet not realize the value of a switch that changes the direction of current flow across the igniter points. Although he knows full well that experience is valuable, he will not pay cash for it as embodied in gas-engine accessories, but will buy it by shutdowns, engine troubles, experts, repair bills, etc., and probably wind up by damning the gas engine, wholesale. I have seen a three days' shutdown caused by a defective igniter that caused a loss of $300, and the user of the engine utilized all of the modern profanity in abusing gas power when his trouble was due entirely to his efforts to buy *cheap*.

The difference between cost and value is of more far-reaching importance and more promptly manifested in the equipment of a gas engine than in any other thing I know of. Simplicity is very desirable, but do not overdo it.

When you buy a gas engine, insist on having everything on that engine that will add to its effectiveness and reliability of operation, and, further, insist that every attachment, auxiliary and appliance be of the best quality that is obtainable. Do not let anyone try to talk you out of it by the simplicity game; if you do, you lose.

Remedy for Lap Seam Boiler Explosions

By the Oil Drummer

Riley laid down his kit of tools, oiled up the flue expander and asked Kelly, the engineer, if he had read the details of the Pittsfield explosion. Kelly replied he had been so busy keeping track of the lap-seam explosions that he hadn't time to follow the others.

Then Riley remarked that the Pittsfield affair was due to a "lap-seam engineer" screwing down the safety valve, which resulted in killing nineteen men, not counting the engineer himself. The engineer, he said had got a bath-tub expert to test his steam gage. Kelly retorted by reading the account of nine men being killed by failure of headers on a boiler in the battleship "Delaware" and laid the blame on boilermakers for this and the lap-seam explosions.

Riley grinned, and said, "Even so, the lap-seam ingineers have beat the reecord as agin the lap-seam biler," and mentioned the explosion on the gunboat "Bennington" in 1905, when sixty men were killed. Kelly offset this with the Brockton explosion wherein fifty-eight persons were killed by a lap-seam boiler.

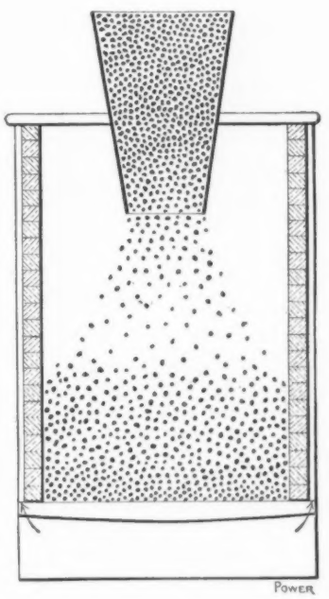
The "old man" blew in at this stage of the argument and settled it by saying that he was figuring on throwing out the steam plant and putting in a gas engine, as he could not take chances on lap-seam boilermakers and lap-seam engineers too.

Honest, do you blame him, the way things are going?

Generator Linings

By C. R. McGahey

A good deal of trouble may be caused by an improperly installed generator lining. If the firebrick is set hard against the metal shell, this is likely to cause trouble because it allows no room for expansion of the brick. Under such conditions it is only a matter of a short time when the brick will begin to crumble and



Air Space behind the Lining

crack, allowing air to pass up through the lining instead of going up through the fire zone. This reduces the capacity and efficiency of the whole equipment. On the other hand, if the brick is not set tightly against the shell, provision must be made to keep the air from passing up between the brick and the shell, as indicated by the arrows in the sketch.

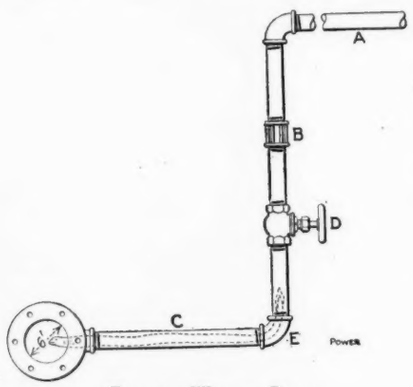
In putting in the lining it is a good plan to allow about 1¼ inches of space between the shell and the brick and, as the brick is being put in, to fill this space with asbestos or magnesia. The lower portion should be well tamped in between the brick and the shell. This not only forms a cushion for the expansion of the brick but serves as a packing to prevent the flow of air up behind the brick lining. A lining put in with a backing of this kind will last many times longer than one put in without it, and make the generator more uniform in its operation.

Readers with Something to Say

Practical information from the man on the job. A letter good enough to print here will be paid for. Ideas, not mere words wanted

Eel in Water Pipe

One summer evening, about a half hour before it was time to start up and put on the lights, the telephone in the engine room rang. I answered the call and was informed that there was no hot or cold water in the kitchen. This was in an industrial school for boys, and I was the only engineer on duty, as the chief was off and my alternate was home. A relief took my place in the engine room until I could locate the trouble and, if possible, remedy it. I tried all the faucets



EEL IN WATER PIPE

about the kitchen, and the valves in the cellar, but there was no water. It was evident that there was an obstruction in the pipe somewhere and to locate it was the difficult part of the task.

The main 6-inch pipe, which was under the cellar floor, was tapped for a 2-inch pipe to supply the part of the building in which the kitchen was located, and this pipe was fastened to the stringers in the cellar. As this pipe was about 80 feet long, it would be a big job to take it all down to look for the stoppage.

Finally a scheme presented itself to locate the cause of the trouble without taking down the pipe. I got a breast drill, a ⅛-inch drill, some wire nails of a size to fit snugly in the ⅛-inch hole, that was drilled at *A* in the illustration, but there was no water. One of the nails was driven in the hole about one-half inch and cut off with the pliers. This operation was repeated several times, until the stop valve at *D* was reached. It was then plain that the trouble was between the stop valve and the main.

As the chief had arrived, he suggested drilling a hole at *C;* this was done, and when the drill went through the pipe, I felt something soft and springy and said, "It's an eel." The main 6-inch valve that controlled that section of the building was closed and the 2-inch pipe cut at *B* and unscrewed at the ell *E*. The eel's tail stuck out of pipe *C* several inches and, putting a wire through the tail of the eel, it was pulled out.

A union was put in at *B* and the line connected again. A 3-foot eel was brought to the engine room alive in a pail, and when skinned and cleaned made a good breakfast for three men.

JAMES W. BLAKE.

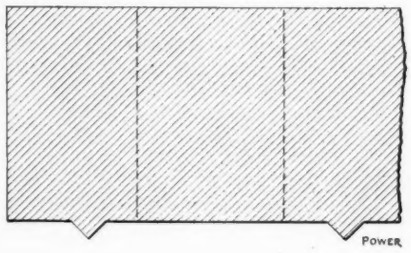
New York City.

Repairing a Pump Seat

This work consisted in reseating the brass delivery deck of a four-valve air pump, of which the cast-iron valve seat had been partially eaten away by the action of salt water.

It was decided to make repairs with lead as the old seat formed a part of the main housing.

First, the delivery-valve deck was put in a lathe and faced up, both on the valve



HOW VALVE SEAT WAS FACED

and under side, leaving a ¼-inch V-shaped ridge on the bearing surface on each side of the stud holes, as shown in the accompanying sketch. The idea was to embed the ridges in the lead seat, this method being considered better calculated to give a proper joint, and also to dispense with the use of a gasket. The lead surfacing was about ⅜ inch thick.

JOSEPH HAMILTON.

Boston, Mass.

Indicator Cord Adjusting Device

Among the many tedious tasks connected with rigging up an indicator none is as bothersome, takes as much time and tries the engineer's patience as much as the adjustment of the length of the indicator cord.

In all cases where the stroke of the piston is longer than the motion of the indicator drum some device is needed to produce a motion within the limits of the indicator drum which is parallel to and

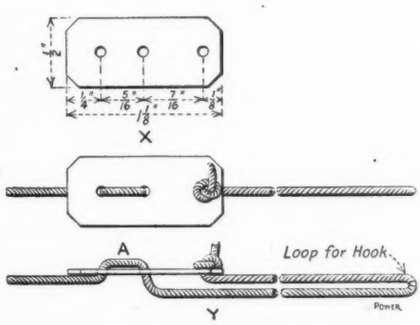


FIG. 1. SHEET BRASS PLATE

in proportion to the travel of the crosshead at all points of the stroke. To accomplish this numerous devices are used and each has its advocates.

The most common are the pantograph and the reducing wheel, which is considered a part of the indicator outfit. But no matter what device is used the first requirement in taking a card is to see that the drum shall not knock at either end of its stroke. This latter requirement depends entirely upon the length of the indicator cord and demands that it shall be in full tension at all points of the stroke. A cord at its crosshead end is generally fastened to a hook and this hook is simply knotted, a slip knot or bowline being the most satisfactory. In nine cases out of ten when the first adjustment is tried the drum will knock at one end of its motion. Then the knot must be untied and retied a number of times before and during the time of taking a set of cards. All this demands valuable time and in reality is quite unnecessary if the device described herewith is used.

Take a piece of sheet brass not less than 3/64 inch in thickness and cut it to the size shown at *X*, Fig. 1. File off the corners and drill the holes on the center line as indicated. These holes should be just large enough to allow the cord to

pass through freely. Be sure to file all around so that no sharp corners or edges are left to cut or scratch the hands. Be sure also to have the holes smooth so that the cord passing through them will not be cut when the string is in tension. This is best done with a very fine strip of emery cloth. Pass the indicator cord through the holes as shown by *Y*, using a plain knot at the end to prevent it from coming out.

When the cord is disengaged it is an easy matter to slide the plate back and forth by pulling the cord slightly at *A* in the direction desired, but when the loop and cord are in tension it will not

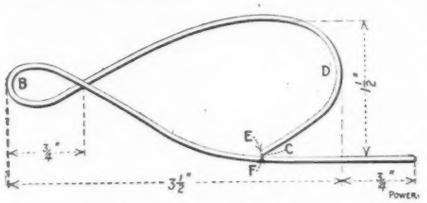


FIG. 2. BRASS-WIRE HOOK

move. If it is desired to move out the end of the loop on which the cord is attached a distance of ⅛ inch, slacken the cord and move the plate ¼ inch toward the hook. If the hook is to be brought further back, slide the plate back twice the required distance in the same manner. In this way it is an easy matter to make a fine adjustment in a few seconds without touching a knot. The size of the plate shown is right for a reducing-wheel cord, but for regular indicator cord increase all dimensions about 50 per cent.

Plates like these are supplied with some indicator outfits and are usually nickel plated, but engineers who do not have them can readily make them in a very short time.

In cases where a reducing wheel is used and the end of the cord is hooked directly to a rod (about ½ inch in diameter and not more than 8 inches long) screwed into the crosshead, and where the stroke is not over 48 inches and the speed not more than 100 revolutions per minute, a very good hook to use at the end of the cord is shown in Fig. 2. It is made out of brass wire of about No. 10 Brown & Sharpe gage and is attached to the loop of the cord at *B*.

To hook on, hold the hook so that it will be about 2 inches back of the rod when it is at the cylinder end of the stroke, and in line with the travel of the rod; then gradually move it toward the rod until it is in such a position that it will strike the hook at *C* and then slip in between *E* and *F* and rest in *D*, thus carrying the hook along. To unhook, stand about one foot back of the hook when it is at the cylinder end of the stroke and, facing the crank pin, put the hand nearest the piston rod around the moving cord, but not touching it. Then gradually move the hand toward the crank until the end of the hook is felt at each stroke. Then close the hand around the cord in back of the hook, but do not grip the cord, and with the fingers of the other hand quickly pull the hook off the rod in a direction *away* from the crosshead in a line parallel to the rod. Be sure to do this when the crosshead is as near the cylinder as it is possible to determine. Thus, the second hand will slip the hook off the rod and the first hand will prevent it from flying back and allow the indicator to come back hard with a sudden knock.

Before hooking in it is a simple matter to hold the hook up to the cylinder end of the travel of the rod and then up to the crank end without engaging it to see if the length of the cord is properly adjusted so that the indicator drum will not knock at either end of its motion.

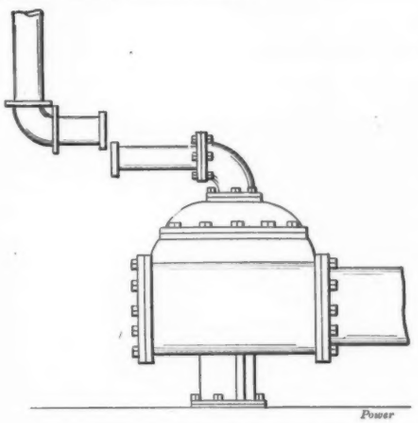
To one who has never tried this method it is advisable to practice when the engine is starting up or stopping, when it is running very slowly, before making experiments when the engine is running at full speed. Three or four trials are quite enough to get the knack of hooking in and out.

H. B. LANGE.

New York City.

Difficult Pipe Fitting

One time when pumping out a mine the manager decided to use a horizontal steam pump that was on hand. The volume of water to be pumped was large and if the pump were shut down for a few minutes the water accumulated very fast, which made the handling of this pump rather inconvenient.



DISCHARGE PIPE OUT OF LINE

Each time the pump was lowered a platform had to be set up on the next landing. Once when the pump was changed the connections on the discharge pipe came together as shown in the accompanying illustration. As the pipe could not be lowered and there was not time to cut a new one, one end of the pump was blocked up and the pipe sprung together.

On moving the pump again, arrangements were made to place the coupling in the vertical pipe. This gave a better chance to make connections in case the pipes did not come together when the pump was moved to a lower level.

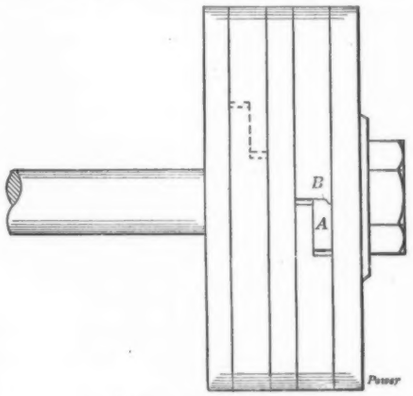
There was never any time to spare when shifting this pump, and on one occasion a new piece of pipe was lowered into the mine with the union on the wrong end. As tools were not at hand to change the union, the pipe had to be sent to the surface to be turned around, and by the time the connection was made the pump was submerged.

EARL E. WEBSTER.

Higley, Ariz.

Broken Piston Ring

One of several large Corliss engines had behaved beautifully for several years, and everything was in good order



PISTON AND RINGS

so far as those interested knew. Then, all at once, the engine began pounding. The brasses were sprung and everywhere that anything could possibly budge was strained. An examination indicated that the trouble was internal.

After taking off the cylinder head, an attempt was made to turn the engine over. The piston moved easily through most of the cylinder, but when it approached the head end where the diameter was slightly less, the piston got tighter and tighter until the aid of jacks was necessary to force the piston over to the counterbore. Drawing the piston from the cylinder until the first packing ring showed, the cause of all the trouble came to view.

The accompanying sketch shows the slotted end *A* of the packing ring, and the line *B* indicates where this end had broken off. The break was an old one and the continual movement of the small piece of metal, confined in the small cavity, had worn one of its ends wedge-shaped. Finally, this wedge slipped under the end of the ring, expanding it to the limit and preventing any contraction. The result was that the piston filled the largest cylinder area and was made a driving fit in the smaller area where less wear had taken place.

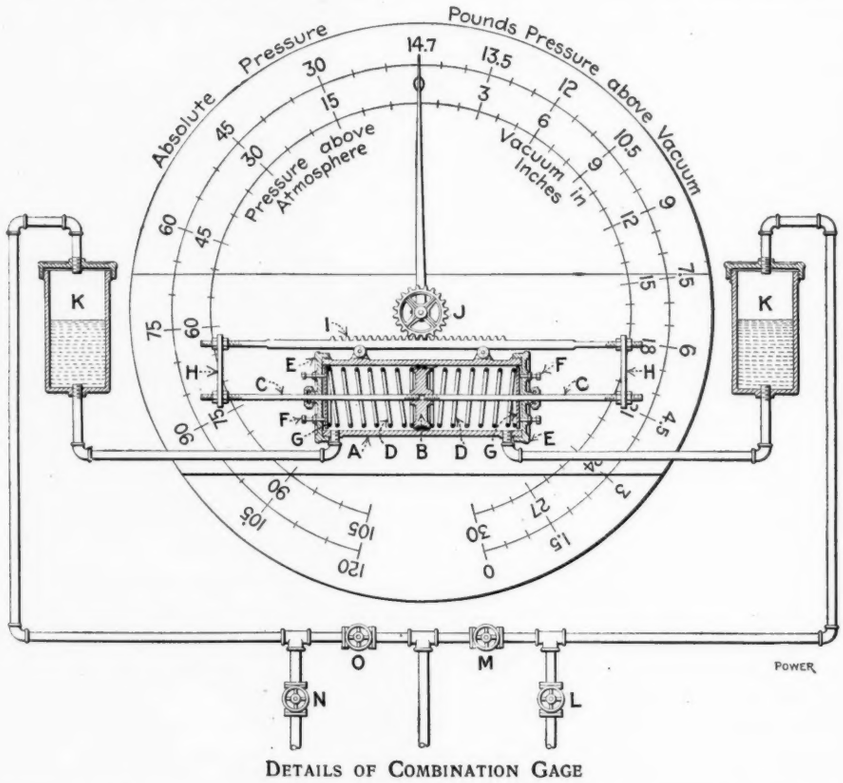
F. WEBSTER BRADY.

Scranton, Penn.

Combination Pressure and Vacuum Gage

Following is a description of a combination pressure and vacuum gage: It consists of a brass cylinder *A*, piston *B*, two piston rods *C*, two springs of different tensions *D* and two cylinder heads *E*. Each cylinder head has four holes for the screws *F* of a very fine thread to prevent leakage which, when screwed in or out, moves the two plates *G* and thus adjusts the tension of the springs. The piston rods are connected by two short rods *H* to a flat, brass gear rack *I*, and the gear engages with the gear wheel *J* to which the pointer is connected. The two drums *K* are to prevent the oil from flowing away.

This gage shows the absolute pressure when connecting the pipe *N* to the live-steam main and the pipe *L* to the exhaust steam. Closing the valve *L* and opening the valve *M* to the atmosphere the gage will register the live-steam pressure, and by closing the valve *N* and opening the valve *O* it will register the exhaust-steam pressure. With condensing engines it is only necessary to connect the pipe *L* to the condenser and the gage will show the mean effective pressure, live-steam pressure and vacuum. If used as a vacuum gage alone, connect the pipe *N* to the vacuum and open the valve *M* to the atmosphere. The pointer will then show the vacuum in inches and pounds pressure above a vacuum.



DETAILS OF COMBINATION GAGE

VICTOR AZBE.

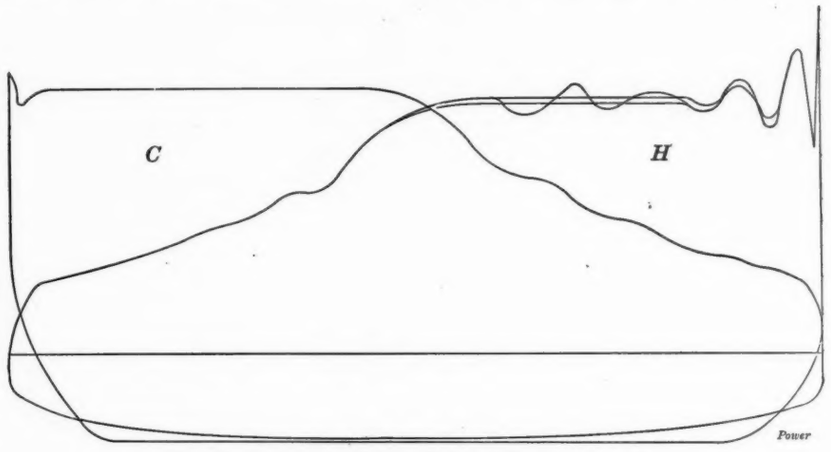
St. Louis, Mo.

Indicator Diagram Defects

The indicator diagram shown herewith was taken from the low-pressure cylinder of a Porter-Allen engine, and diagrams taken from three other engines of the same type show the same lines. These engines are all run compounded in the summer season only. The low-pressure cylinders are disconnected and the engines are run simple for the sake of exhaust-steam heating during cold weather.

The irregularity of the diagram at the point of admission has puzzled the engineer in charge, particularly as several different indicators have been used on these engines.

The speed of each is 157 revolutions per minute and the initial steam pressure in the 24x30-inch low-pressure cylinder is 30 pounds. A vacuum of 21½ inches is maintained. Why do not the same defects show on both ends of the diagrams?



WHY ARE NOT BOTH DIAGRAMS THE SAME?

EDWARD T. BINNS.

Philadelphia, Penn.

Disposing of Back Numbers

This seems to be an opportune time to say a few words in regard to disposing of the technical magazines of 1910. Some engineers allow them to accumulate until they are in the way, and then destroy them. Others clip such portions as are of special interest, and destroy the remainder.

These methods are a more or less shameful waste of valuable literature. I have had POWER for 1909 bound in two volumes, by a local bindery, and I am going to have the numbers for 1910 bound in the same way.

To prepare the paper for the bindery, I remove the advertising matter, retaining the editorial page in the front and the page entitled "Moments with the Ad Editor," at the back of the paper, also the pins.

Several engineers with whom I have discussed the subject, and who formerly destroyed their papers, are having them bound. To some this may seem expensive but I think it pays, for in these papers we have accounts of interesting experiments and tests, letters from practical men who give us the benefit of their experience in getting out of difficulty and relate all kinds of stunts and kinks, some one of which may just fit an individual case.

Inquiries of general interest, with answers, are always instructive, also many illustrations of new things for the power plant, and valuable information relating to their construction and operation. This subject as a whole comprises a reference library which can be obtained in no other way, and which, if properly bound, makes a pleasing addition to any engineer's bookcase.

J. A. LEVY.

Greenfield, Mass.

Questions Before the House

Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues

Leakage through a Piston Valve

In the issue of November 29, Mr. Allen's criticism of Mr. Mitchell's article dealing with the matter of leakage through a piston valve is interesting.

For some time it was quite the fashion to discredit this type of valve. But now, thanks to the experiments of Messrs. Callendar and Nicolson, and to the subsequent efforts of designers and makers of this valve, it has quite rehabilitated itself and it is remarkable that the world's

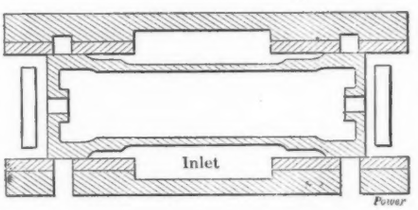


FIG. 1. DIAGRAM OF ORIGINAL VALVE

records for economy on two different types of engines were obtained with this valve.

Mr. Allen's remarks on the advantages of the piston valve are quite in agreement with the experience of makers in England, and, as indicated above, there are some who are prepared to go further than he on the matter of economy if the valve be used with superheated steam.

In Mr. Mitchell's description of his experiments he stated that many schemes have been devised for measuring the amount of the leakage, but in general they are crude and for many reasons the results cannot be regarded as accurate; he then mentions the most important defect common to all of them and straightway embodies it in his scheme.

Had he read the literature on this subject he would have come across Messrs. Callander and Nicolson's experiments and would have seen how inaccurate his statement is, and the study of the subject might have been benefited by his attempting to improve upon the methods of these experimenters.

That there is a great difference between the leakage of a valve or piston when standing and when running seems to be quite understood, yet the first tests were taken with the valve and piston moving, and in order to separate the leakage of the piston from that of the valve the tests were taken with the piston standing.

The fit of the valve when it was tested was stated to be perfect; if this were so, then a great opportunity for taking a valuable test has been neglected; however, what was this fit? Was the clearance measured in ten-thousandths or in thousandths of an inch? Or, was steam turned on and found not to leak past the valve when it was standing?

The fit of the piston was not stated; if it had been an ordinary commercial fit then, when standing, steam would not have leaked past it; the fact that it did leak when standing showed that it was not a good fit; it is improbable that the tests would have been taken had the experimenter considered that this was not a good fit, so possibly his idea of a perfect fit was little better, and the extraordinary amount of leakage is explained.

It is difficult to see why it was decided to have a special valve for these tests;

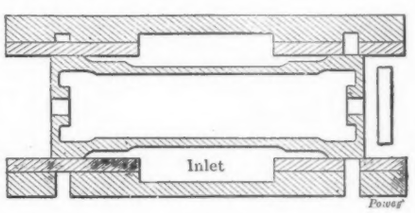


FIG. 2. SAME VALVE WITH SOLID LINER AT ONE END

the preparations would have been much cheaper and the tests carried out much more accurately and expeditiously if the arrangement shown in the accompanying figures had been adopted.

This arrangement obviates the plugging up of any port, which is a very desirable feature, as it was stated that the plugging up of the cylinder port was not successful and it is probable that the plugging up of the exhaust port from the valve was equally unsuccessful, but in this instance unnoticed.

Fig. 1 shows the original valve and its liners. During the tests this valve was replaced by one which admitted steam to the head end of the cylinder only, and the exhaust port at the crank end was plugged up.

Fig. 2 shows the original valve and one original liner, the other liner being new and without ports so that steam cannot get from it either into the cylinder or into the exhaust pipe; the liner in the head end is easily replaced without dismantling the cylinder and the new liner should be inexpensive.

A pipe can be led from a hole in the head-end valve cover to the condenser and so all the leakage from that end of the valve can be measured; another pipe could be led from the relief-valve hole in the head end of the cylinder to another condenser and so the leakage from the piston measured.

It is seen that with this arrangement it is possible to take very accurate tests of the valve and of the piston leakage separately and simultaneously, and it is hoped that Mr. Mitchell, or anyone who is able to, will use this idea or an improvement on it and repeat the experiments.

If experiments could be made with various types of valves, the results would be most interesting and valuable. When making the tests it should be kept firmly in mind that one assumption vitiates the whole of the test, and that the full data of the tests should be published.

A. VINCENT CLARKE.

Gainsborough, Eng.

Washing Boilers Externally

A correspondent in the December 27 issue inquires as to the advisability of washing the fire surface of the boilers under his charge.

With one battery of boilers I did this for several years with no ill effects. The external washing was done, of course, only when the boiler was down for cleaning and, as the correspondent says, there was heat enough to dry off the surfaces.

I cannot say that I advise external washing, though, for the conditions vary so much; because it proved to be all right in one case does not insure it to be so in all cases.

Filling a boiler with cold water after cleaning is something I much dislike to do, on account of the severe contraction strains set up and the corrosive effect of the sweating that takes place; the temperature of the water does not need to be high to prevent this; 140 degrees or more will do.

J. O. BENEFIEL.

Anderson, Ind.

Setting Us Straight

Method of Banking Fires

Regarding the question under the above caption in the December 20 issue, M. B. F. makes no explanation as to how thick the grates are covered with fuel or the method employed regarding the fuel on the grates.

Closing all doors and dampers is, of course, right, but in addition the fires should not be left on the grate bars or given an ordinary covering of coal. The proper method of banking fires is to push back the fuel from the front of the grate and then cover the live fuel on the rear of the grate with fresh coal to a depth of not less than 3 inches. Closing all drafts will result in finding the fuel ready for work the following morning, when it can be set into active combustion by simply opening the drafts, pulling the fire over the whole grate and adding a little fresh coal.

I would strongly oppose the suggestion of opening the flue doors to overcome any air leak that may be in the damper, because opening the flue doors means that a current of cold air is being continually drawn through the tubes, causing a chilling of the boiler, which is opposed to engineering practice. Furthermore, flue doors are seldom any too secure or tight and if they are opened at night the chances are that they will leak in the day time. Any plant operating with natural-draft conditions will be subjected to an intake of air at any leaky flue door, greatly to the detriment of the economy of steam production and also to the welfare of the boiler. M. B. F. will do well to leave his flue doors closed both day and night and to see that there are no leaks at that point. On the other hand, he should study the matter of leaving a part of the grate surface exposed, covering the fire a little heavier on the rear end as suggested above.

Steam for Preventing Clinkers

In the December 13 issue the following inquiry and answer are given:

"I have been told that a jet of steam under the grates will prevent the formation of clinkers. Is this true, and is it an economical practice?

"S. P. C.

"Clinkers are caused by the melting and running together of the incombustible in the coal by the heat of the fire. If steam enough is passed through the fire to keep the temperature below the melting point of the ash, clinkers will not form. It is certain that there is no economy in using steam to reduce the temperature of the fire under the boiler which makes the steam."

It is very evident that the answer given was hastily and thoughtlessly furnished, as it is entirely misleading and a very incorrect opinion might be formed by anyone reading it who is not thoroughly conversant with the subject.

What are the facts? Strictly speaking, ash does not melt at all. Clinkers are caused by the fusing of certain elements in the fuel; these elements may be sand, silicate, sulphur, etc.

In coal, the formation of clinker shows different characteristics; in some cases the clinker is very easily broken up and is not in any sense of the word a detriment; in others, it fuses and becomes a part of any firebrick with which it comes in contact and cannot be broken off except at the expense of the firebrick to which it adheres; in still other instances, clinker is so serious a trouble as to compel a cessation of the use of the fuel which produces it.

The detriments of clinker are well known. If the clinker only causes extra labor in the manipulation of the fires, just that excess is a cost. On the other hand, its presence may result in loss of brickwork or loss of active grate surface in the fire.

How, then, is clinker to be prevented? The only successful means of preventing clinker is the use of a steam jet under the grates. In doing this, careful study should be given so that the steam will be uniform under the entire grate surface and yet not of sufficient volume to reduce the temperature of the fire. It is quite unnecessary that the temperature of the fire be materially reduced in order to prevent clinker; in fact, if the temperature were materially reduced by the use of steam jets there would be loss of economy, as the actual steam used and the excess fuel burned would more than offset any cost due to clinker.

How, then, should the steam jet be applied? Its most common and only successful application has been in the form of steam-jet blowers, and it has been the constant aim of the manufacturers of steam-jet blowers to reduce the amount of steam that they use for motive power and reliable manufacturers are now placing on the market blowers which are guaranteed on this particular point.

The use of a steam-jet blower can be for the purpose of increasing the draft or it can be for the purpose of eliminating clinker, or both. I remember very well a certain plant to which my attention was called by an urgent telephone message to the effect that it was impossible to hold steam. On investigating, I found the plant running under natural-draft conditions, although the furnace was equipped with the Parson steam blower. By inserting a slice bar the fuel was shown to be fused together to an extent that rendered the whole one sticky mass, as might be evidenced in a pan of taffy. With the means of a slice bar and a common two-prong hook, I had the fire torn apart and then the steam blower was set in operation. Using the same fuel and with the steam blower in operation, inside of a half hour I had a thoroughly satisfactory fire and the boiler was developing its full requirements of steam and this without objectionable clinker from the fuel.

Such an experience as this, together with hundreds of others of similar conditions which I have personally investigated, would absolutely disprove the statement made in the answer under discussion, that the temperature of the fire must be reduced in order to prevent the formation of clinkers.

By the use of a pyrometer I have found that the amount by which the temperature is reduced when using a proper steam-jet blower is almost negligible, whereas the formation of clinker is eliminated or certainly reduced to a point where it is not objectionable, using fuel which clinkered badly with fan or natural draft.

Again referring to the item under discussion, the statement therein made that "It is certain that there is no economy in using steam to reduce the temperature of the fire under the boiler which makes the steam" is one that would suggest the conclusion that there is no economy in using steam jets or steam blowers.

I can cite hundreds of cases where the use of a steam jet has not materially reduced the temperature of the fire, although it successfully eliminated objectionable clinker; therefore, it is quite unnecessary to say that "There is no economy in using steam to reduce the temperature," because steam is not used in sufficient volume to reduce the temperature nor does it materially reduce the temperature of the fire; in many cases it positively improves it.

Using jets made of ordinary pipe has been common practice, but I would suggest that the steam jet used be supplied by means of a proper form of blower as being the most economical and best method of accomplishing two purposes.

Horsepower and Boilers

Another inquiry in the December 13 issue requested the rating of horizontal tubular boilers with respect to the amount of heating surface. The reply given was to the effect that horizontal tubular boilers were rated on a basis of 10 square feet of heating surface per horsepower.

While it is quite true that makers of horizontal tubular boilers at the present time base their rating on 10 square feet of heating surface per horsepower, claiming this type to be fully as efficient as the water-tube type, it is not true that this is a common rule, and for years back manufacturers of horizontal tubular boilers have established rating on a basis of one to fifteen; then, later, they established a basis of one to twelve.

While it is true that horizontal tubular boilers are capable of high overrate, the inquiry was directed by an engineer who had a boiler already produced and not a

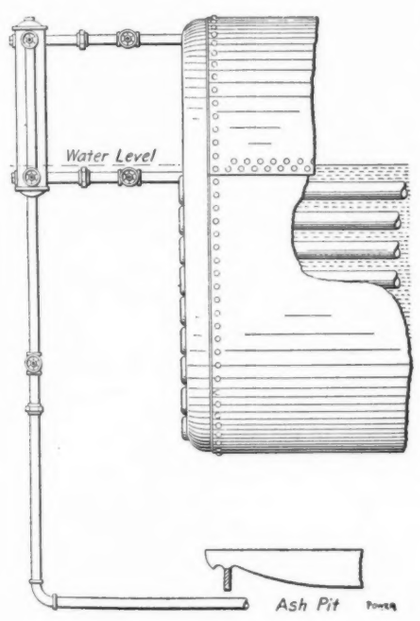
boiler which was being made at the present time; I therefore suggest the development of this subject so that the engineer asking the information may be in full possession of the subject rather than being given an answer which he would find flatly contradicated by a very large percentage of operating or professional engineers. The real difference between the efficiency of a water-tube boiler and that of a horizontal tubular boiler lies in the difference in the settings.

CHARLES H. PARSON.

New York City.

Water Gages

In the December 13 number of POWER Mr. McGahey favors valves in the water-column connections. I think he is right on that point, but his sketch shows a poor way of connecting the column. Also the column is in a bad position in regard to the water level. I submit the accompanying sketch as showing an improved layout. The sketch is self-explanatory. With the blowoff piping arranged as shown, the column can be blown down with even greater convenience than in the case where the column is arranged as per Mr. McGahey's sketch.



IMPROVED ARRANGEMENT OF WATER-COLUMN PIPING

L. JOHNSON.

Exeter, N. H.

If there is anything worse than no water column on a steam boiler, it certainly is one arranged as shown by C. F. McGahey in the December 13 issue of POWER. No doubt a good many readers would like to have Mr. McGahey lay out a front view of his column arrangement, as it probably would enrich their conceptions of the fourth dimension. I have always been under the impression that a gage glass should show the hight of the water *above* the tubes and not *below*. Another thing I consider to be poor engineering is the use of gate valves on columns, where impurities are liable to clog the pipes.

H. F. HEYRODT.

Bridgeport, Conn.

Trouble with a Heating Plant

In regard to Mr. De Saussure's problem, as described under the above heading in the January 10 number, in my opinion the equalizing pipe on top of the receiver tank, if properly connected, serves mainly to facilitate the work of the pump and guard the tank against a vacuum; hence, this equalizing pipe has no effect on the distant group of radiators.

Since he has a seal at *A*, the water line in the returns must be about where the dotted line is; but what causes the see-saw is the steam pipe at *A* running from the main to the seal trap, which "buck" against the regular flow of water from the horizontal return until the water line *A B* is high enough and the pressure in the radiators sufficiently equalized to start a sudden rush of steam and water down *C*, the arrangement at *A* acting as an injector for the time being.

I am not of the opinion that the pressure in *C* ever drops; further, I do not think that the gage is at the proper point to indicate any variations in the pressure in pipe *C*. As soon as the siphon-like action ceases on account of lack of water, the pressure at *B* will be at its lowest, and it will gradually increase as the seal *A* becomes full of water.

I should say that the elimination of pipe *A* from the main to the seal would stop the trouble. Then, pipe *C* would have the steady drop in pressure necessary to allow a regular steady flow to the receiver.

ALEX DOLPHIN.

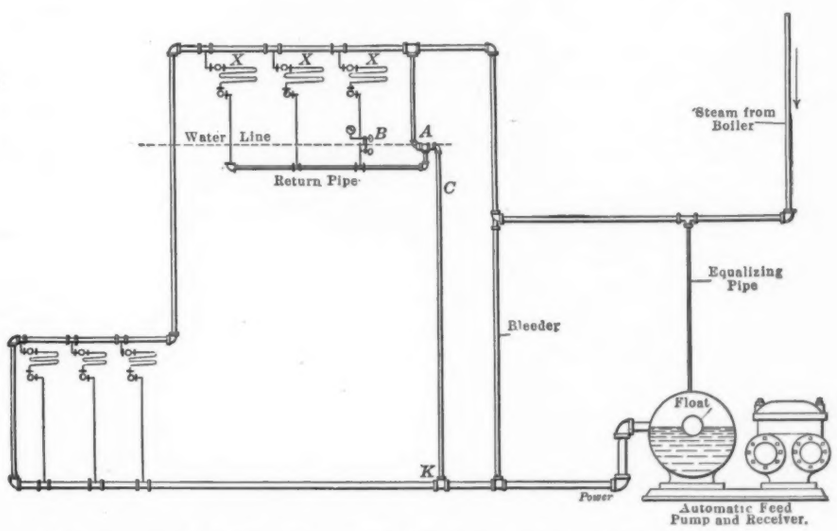
Jamaica, N. Y.

Boiler Explosions

In many of the accounts of boiler explosions I see this statement, "The boiler was being limbered up after being idle for some time" or, "The boiler had not been used for some time." I believe that many boiler explosions have been caused by getting the boilers under pressure too rapidly after they had been idle for a longer or shorter period.

When a boiler has been standing cold for some time, the steam gage is more likely to become stuck than at other times. The spring may not throw the needle accurately.

I noticed in the account of the Pittsfield explosion the statement that the steam gage showed only 35 pounds pressure, while there probably was a pressure of 125 pounds or more on the shell of the boiler.



REPRODUCTION OF FIG. 1, SHOWING ARRANGEMENT OF HEATING SYSTEM

Once, while running a battery of boilers in a plant in New England, I was getting up steam in Nos. 1, 2 and 3. When I noticed that the gages on Nos. 1 and 3 showed 40 pounds while that on No. 2 showed only 10 pounds pressure, I knew by the fires, water, etc., that the No. 2 gage ought to have shown as much pressure as the others. I gently rapped and shook the gage and the needle came right up to the proper mark.

I believe that in every plant that has only one boiler, the boiler should have two steam gages. Then, if one happens to stick there is not one chance in a hundred that the other would register wrong also.

W. J. STARKE.

West Cummington, Mass.

Boiler Explosions in Germany

The editorial under the heading "Boiler Explosions in Germany," in POWER for December 20, should make one sit up and think. Why have we so many explosions in this country? There must be something radically wrong. Perhaps there may be a few reasons.

Germany has no coroner handy with the whitewash. The officials whose business it is to investigate such accidents are installed and shielded by the government and all stand on their honor, which is worth more to them than mere dollars and cents. They never bow to the dollar sign. They do their duty no matter whom their action hits. They are sticklers in upholding the law; try to bribe one and see how quick the briber goes to jail. When a boiler explodes, killing one or more persons, the district attorney with a circuit judge goes to the scene.

The attorney and the judge conduct the inquest. Experts are summoned, only such men as hold master certificates and are well qualified, also the inspector who last examined the boiler being eligible.

These men sift the evidence and no one dares to block their efforts. They need fear no political wrath, for all hold their jobs for life, unless promoted, and promotion comes according to ability in enforcing the law. If, in their investigation, they find someone negligent, the blame is placed; it makes no difference who the party is or whether he is of high or low rank. And the blame is often found to be with someone "higher up" that is living (not a dead man or a dying engineer; remember Brockton, Mass.).

The man responsible is then placed under arrest immediately. At the trial he is charged with such a crime as the inquest seems to indicate. He must clear himself if he can; nine times out of ten he cannot. Sentence is pronounced if he is found guilty; the penalty usually is not a fine because this only hurts the pocketbook; generally it is a jail sentence.

If we had some of this in our great and glorious United States, what a blessing it would be! Look through the list of explosions and one cannot help but shudder. How many dead men there are with blame resting on them of which they are innocent! But, dead men tell no tales.

A. RATHMAN.

Chicago, Ill.

Metallic Packing

In answer to the question by W. D. Marquest in the December 13 number concerning metallic packing, I would say that if he will indicate his engine he will probably find there is back pressure at the end of the crank-end stroke which is so high as to produce a pressure on the packing greater than that due to the boiler pressure.

If there were back pressure at the other end of the stroke it would not have any effect on the packing or rod, as the piston would be between the pressure and the packing. I still have the first rod that was used in my engine; it is worn tapered at the crosshead end.

The tension of the springs causes but very slight wear.

W. H. PHELPS.

Ellwood City, Penn.

Does the Crosshead Stop?

I have been reading the arguments on Mr. Fryant's question, "Does the Crosshead Stop?" My opinion was that it did. I wanted to know for sure so I made a wooden cylinder and mounted it beside the engine with its axle parallel with the crosshead. I kept it in motion by a string running around the shaft of the engine, around two spools and then around the cylinder. Then, by placing a piece of paper on the cylinder, fastening a pencil to the crosshead so that the point just touched the paper, I was ready to take a diagram. I turned the engine over once by hand and secured the diagram shown in Fig. 1. This diagram proved beyond a doubt that the crosshead does not stop for, if it did, there would be a straight line at *A* and *B*, Fig. 1. As the ends of the diagram are curves, the crosshead did not stop. I took this diagram from a high-speed automatic engine with a 14-inch stroke.

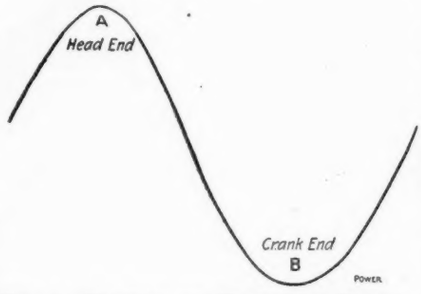


FIG. 1. DIAGRAM OF CROSSHEAD TRAVEL

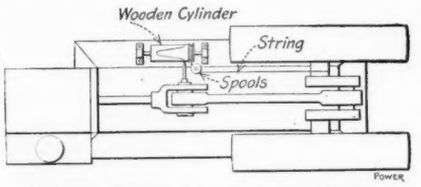


FIG. 2. ARRANGEMENT FOR DRAWING DIAGRAM

The curve at the head end of the diagram is somewhat sharper than that at the crank end on account of the crosshead having a quicker motion during the head-end half of the stroke.

WILLIAM T. KINGSLEY.

Boise, Idaho.

Fusing Temperature of Ash

The discussion by J. V. Hunter in the issue of December 27 of the article on "Fusing Temperature of Ash," which appeared in an earlier issue, is very interesting, and bears out conclusively the contention that the clinkering property of coal bears no relation whatever to the percentage of sulphur in the coal.

All other usual determinations, such as the percentage of iron in the ash, percentage of lime, etc., apparently fail in indicating this characteristic, and the only test which we have found to be consistent is that of determining the fusing temperature of the ash.

Mr. Hunter says that few people are in a position to obtain these data and it is reasonable to suppose that sole reliance must be based upon actual tests conducted in the plant. This is true to a certain extent, for even the proximate analysis of the coal, the B.t.u. determination, the percentage of CO_2 in the flue gas, etc., are only of value when properly interpreted in connection with actual operating conditions. The purpose and value of such tests, however, are that they serve as definite and reliable indications of the suitability of various fuels or conditions for securing the best results in practice.

In the past, the only method of determining the clinkering property of coal has been to burn it, and while it is true that the "proof of the pudding is in the eating thereof," yet it is often very desirable to learn before the pudding is eaten, or the coal burned, whether or not the act is going to result disastrously in either case.

In many of the larger power plants today, capacity is of primary importance. The greatest enemy of capacity, as well as efficiency, is the formation of clinker, and it is certainly very desirable in every possible case to prevent the disastrous procedure of trying out in practice all of the various kinds of coal which may be shipped upon a contract, by providing limitations of the fusing temperature of the ash in the specifications with suitable penalties and premiums, just as are imposed upon variations in the B.t.u., percentage of ash, etc., in many cases today. In other words, the fusing temperature of ash is a short cut to determining before a coal is placed in the furnace, or even before it is delivered to the plant, whether or not it will be suitable, without having to wait until the plant is shut down for lack of steam, due to lack of air with which to burn the coal.

We hear a great deal today about the heat value of coal, and the percentage of CO_2 in the flue gas, but neither can the maximum B.t.u. be developed, nor the best percentage of CO_2 be obtained if the ash forms a clinker which slags over the grate and prevents the flow of air through the fuel bed.

It is true that there is a great variation in the amount of clinker formed in different furnaces, due to the method of handling the fire, and every engineer and fireman should remember that any ash should be kept as cold as possible, thereby preventing undue risk from heating it up to, or far beyond, its fusing temperature. However, under similar conditions, whether they are good or bad, the fusing temperature holds a relation which indicates the comparative values of different coals, and it is comparative quantities that are of value in engineering practice more than absolute or theoretical figures.

Mr. Hunter referred to the practice of mixing coals, and its effect upon the formation of clinker. His conclusions on this are in general correct; in some cases it may be helpful to the more troublesome coal, while, on the other hand, the mixing may cause serious trouble, while either coal burned separately might give satisfactory results.

Mr. Hunter also mentioned the possibility of adding ingredients, such as lime and silica to the ash, in order to eliminate this trouble. This point has already been taken up by W. N. Wing in the November 22 issue of POWER and discussed by E. Dixon in the December 27 number. In the case under discussion, Mr. Wing spoke of using oyster shells to remove clinkers from a boiler furnace, and there is no question but that he might have received some benefit from the use of lime in this form, but as to the action of lime, I differ with Mr. Dixon in this connection and do not believe that the lime added lowered the fusing temperature of the ash by fluxing it, but that it increased the fusing temperature of the ash. With a certain composition of ash, lime added, up to a certain percentage, may act as a flux, but as lime itself cannot be fused much below the temperature of the electric arc, it would certainly increase the fusing temperature of any ash if used in sufficient quantity, and this is probably what Mr. Wing did. I have known of other cases where oyster shells have been used in lessening the trouble from clinker. I have also learned that from some mines, coal with a higher percentage of ash due to the admixture of certain kinds of clay and slate which were high in alumina increased the fusing temperature of the ash and lessened the trouble from clinker, and there is a possibility that in the future coal may be treated in order to prevent clinker as feed water is now treated in order to prevent scale. This, however, can only be done by adding other material, the composition of which will depend upon the nature of ash which is already inherent in the coal, and while it may be feasible in the case of coal which has a low percentage of ash, yet where a high percentage of ash exists in the coal a greatly increased percentage of the added material would probably offset any advantage gained thereby.

E. G. BAILEY.

Boston, Mass.

Why the Feed Pipes Clog

In regard to Mr. Piper's letter in the January 3 issue under the title, "Why Did the Feed Pipes Clog?" it is my opinion that the trouble is due to iron in the water.

I have had the same trouble. If Mr. Piper will have the water analyzed, he will probably find that it contains iron. This forms a reddish scale.

PETER ELSETH.

Crookston, Minn.

Faulty Design and Economic Engineering

In POWER for November 22, R. L. Rayburn speaks of the engineers in charge of plants, knowing the plant as no others do, as a reason for not securing the services of a competent consulting engineer. As the general run of chief engineers are usually busily engaged in making necessary repairs and changes, they are left but little time to spend in convincing the management of the necessity of making needed changes or improvement in equipment; while the consulting engineer has little else to do. Moreover, it is well known that a man's personal appearance and standing or reputation has much to do with the consideration given his propositions. Very frequently it is the case that the management does not like to have the engineer become the advisory board. In such cases the consulting engineer can and does play a very useful part, as the engineer can have his plans carried out through the consulting engineer.

A chief engineer in charge of a plant cannot reach the management for an audience until he has risen in their esteem and subsequently in the ranks of men, through his everyday efforts and achievements.

Of course, there are consulting engineers *and* consulting engineers, those of good repute and otherwise. No man would commend the practice of employing a man as chief engineer in charge of plant, just because said man had made a failure in some particular plant. I have been wondering what Mr. Rayburn's impressions are of what a consulting engineer really should be capable of; we may call a man a consulting engineer or he himself may assert that he is capable of performing the duties of a consulting engineer, but that does not make it so. To become a successful consulting engineer, it is necessary first to apply the theories, and your own hypotheses to everyday practice. A man rises to such a position by a gradual process. Perhaps he should first be the chief engineer in charge of a plant before he should consider himself eligible for the duties and responsibilities of the consulting engineer.

There are different types of consulting engineers. Unquestionably, a man should specialize along some particular line of work.

It is only natural to find men terming themselves "consulting engineers" who in reality are entirely unfit to design or lay out a power or heating plant. I have known college graduates to establish offices in cities and term themselves consulting engineers; certainly we would not expect such persons, just out of college, to be capable of laying out a power plant, neither would we expect a good business man to employ such impostors.

I say that the consulting engineer will play a more important part in the operation of light, heat and power plants each succeeding year, as a man of caliber, high standing and achievements will be necessary to make the final determinations and to display sufficient tact in presenting a new layout or proposed change to the management.

Perhaps a great many of the changes, etc., were the ideas of the engineer in charge, but the changes often never would be made if they were presented to the management by the engineer. This is an age of salesmanship, an accomplishment which the engineer does not frequently possess to any marked degree.

In conclusion, I assert that the isolated plants cannot expect to withstand the onslaught of the central stations unless they, too, are organized in a concrete body as the central stations are. Also, they are ultimately doomed unless the same high standard of salesmanship is resorted to, in order that the management may be convinced that it would be cheaper and better to operate its own plant. This high-grade salesmanship must be one of the attainments of the consulting engineer, as he is in such standing with the management that the engineer in charge can never attain.

WALDO WEAVER.

Middletown, O.

When cutting pipe threads in a lathe it is sometimes difficult to get the exact diameter necessary. When a mistake is made and the threads on a 6-inch pipe are cut a trifle too small, so that it screws right up to the shoulder, then it remains for the workman to get out of the trouble the best way he can. A very good way is to use wire cloth of the brass variety, about 60 or 80 meshes to the inch, similar to that used by the farmer for straining his milk. Wrap a bit of wire cloth around the pipe, daub it with litharge or red lead and screw the pipe home with the wire cloth in the joint. This joint will never leak or come loose.

Inquiries of General Interest

Questions are not answered unless accompanied by the name and address of the inquirer. This page is for you when stuck—use it

To Make Pipe Covering Stick

How can asbestos be made to stick to steam pipes and cylinder heads?

P. C. S.

Give the surface a coat of silicate of soda, sometimes called liquid glass, and before it has time to dry apply dry asbestos as thick as possible by handfuls. The silicate will stick to the surface and hold enough asbestos to serve as an anchor for the following coats to be applied in the usual manner.

Reasons for Compression

What reasons are there for giving compression when setting engine valves?

R. F. C.

Compression reverses the direction of pressure on the pins and main bearing of an engine gradually, takes up the lost motion without shock and allows the crank to pass the centers quietly. It also fills the clearance space with exhaust steam instead of with steam from the boiler.

Safety Valve and Steam Gage

If with a safety valve set to blow at 80 pounds the steam gage should show a pressure of 120 pounds, what should be done?

S. S. G.

The pressure should be reduced, the boiler cooled and both gage and valve tested by a competent man.

Reducing Size of Eccentric

If ⅛ inch is turned off the outside of an eccentric, how will it affect the valves and the speed of the engine?

R. S. E.

In no way whatever.

Capacity of Duplex Pump

How many gallons of water will be delivered by a duplex pump making 30 strokes per minute with 4x6-inch water cylinders?

C. D. P.

The area of the 4-inch piston is 12.56 square inches and 75.36 cubic inches of water will be delivered per stroke. Both pistons will, together, make 3600 single strokes in one hour and the quantity of water pumped will be

$$\frac{75.36 \times 3600}{231} = 1174.44 \text{ gallons}$$

Cutoff with Lapless Valve

If a slide valve has neither lap nor lead, at what point in the stroke will the cutoff take place?

C. L. V.

At the end.

Badly Scaled Boiler

In case a boiler is found to be badly scaled, what should be done?

R. S. B.

It should be thoroughly cleaned at once.

Thickness of Strap Plates

Why are the cover plates or straps of a butt and strap joint made thicker than the shell plates, and why can they not be made thinner?

T. S. P.

They are never made thicker than the shell, but on the contrary are frequently thinner. They should never be less than five-eighths of the thickness of the shell plate.

Center of Shaft

Does the center of a shaft revolve?

C. O. S.

It does not.

Diameter of Steam Pipe

What diameter of pipe 1000 feet long will be required to deliver 200 pounds of steam per minute at a velocity of flow of 100 feet per second with a drop in pressure of only 5 pounds; from 100 to 95?

D. S. P.

No diameter of pipe will fit all the conditions. A 6-inch pipe will deliver 200 pounds per minute with a drop in pressure of only 4½ pounds, but the velocity flow will be only 4000 feet per minute. A 5-inch pipe will give a velocity of flow of 6000 feet per minute for 200 pounds delivery, but the pressure drop will be 11 pounds per square inch.

Increasing Speed of Fan

I have a 7-foot fan running 187 revolutions per minute and I wish to increase the speed to 400 revolutions per minute. The fan is driven by an 8x8-inch engine running 153 revolutions per minute with a steam pressure of 100 pounds. How can I make the change?

I. S. F.

You cannot do it. The power required to drive a fan is approximately as the cube of the speed. A 7-foot fan at 187 revolutions per minute takes about 20 horsepower, which is about the limit of your engine at its present rate of speed at 60 pounds mean effective pressure in the cylinder. To drive the fan at 400 revolutions will take over 90 horsepower, which means an increase in piston speed or mean effective pressure beyond what is possible. The safe speed for the fan will fall below 275 revolutions per minute. These and other reasons, any one of which is sufficient without the others, will show why it cannot be done.

Weight of Boilers

What is the weight of a 60-inch and a 72-inch return-tubular boiler?

W. O. B.

The weight of a 60-inch return-tubular boiler without front or fittings varies according to length, etc., from 10,000 to 13,000 pounds; complete from 17,000 to 18,500 pounds. The weight of a 72-inch boiler will range from 14,500 to 26,000 pounds, depending on length and equipment.

Horsepower of Boiler

What is the horsepower of a horizontal return-tubular boiler, 6x18 feet, containing sixty 4-inch tubes, allowing 12 square feet of heating surface per horsepower?

H. O. B.

The heating surface of a horizontal tubular boiler is the total area of one-half the shell, the inside area of all the tubes and the area of one head less twice the cross-sectional area of all the tubes. One-half the area of the shell equals,

$$3 \times 3.14 \times 18 = 169.56 \text{ square feet}$$

The inside tube area is equivalent to

$$\frac{11.72 \times 18 \times 60}{12} = 1054.8 \text{ square feet}$$

The heating surface in the head would be

$$28.27 - \left(\frac{12.56 \times 2 \times 60}{144}\right) = 17.42 \text{ sq.ft.}$$

The total heating surface in the shell, tubes and heads would then be

$$169.56 + 1054.8 + 17.42 = 1241.78$$

square feet which would give a horsepower rating of

$$\frac{1241.78}{12} = 103.48$$

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POWER

Reliability of Test Figures

Tests, such as those of engines and boilers, are so flexible that it is an easy matter to deceive oneself as to the results that are obtained. No wonder, then, we are startled now and then by the published reports of such phenomena as a boiler efficiency of eighty-five per cent. and the like. Not infrequently such reports are given out over the signatures of men whose integrity is above the slightest suspicion, in which event the figures are quite startling.

When men whose ability is beyond question and who have absolutely no motive in deceiving themselves about the performance of a given piece of apparatus can induce themselves, by virtue of their faith in the results obtained, to sign reports which indicate performance considerably beyond the ordinary, it is small wonder that a manufacturer, or his chief engineer, can persuade himself to believe that his observations are reliable even when they indicate results that border on the impossible.

Results apparently secured are shown by the observations made by the persons conducting the test. These observations depend for their accuracy upon the calibration, precision and manipulation of the instrument used in making the observations. Even after an instrument has been found to be accurate, unless it is used carefully and intelligently, the indications which it makes may be far from the truth, as the following tends to show:

The man in charge of the Orsat apparatus during a certain boiler trial found that the percentage of carbon dioxide as indicated by the apparatus was too high. It would go as high as from seventeen to nineteen and the percentage of oxygen indicated would be nine or ten. Obviously, something was wrong, as the total of the quantities of carbon dioxide and oxygen amounted to from twenty-six to twenty-nine per cent., which is from five to eight per cent. in excess of what is theoretically possible.

For some time the operator was wholly unable to discover where the trouble was. After some searching, he discovered that the time taken in manipulating the apparatus had much to do with the percentage of carbon dioxide indicated. Strange to relate, however, the more rapidly the flue gas was passed back and forth between the measuring burette and the absorption pipette the *higher* would be the indicated percentage of carbon dioxide. Next, he noticed that the rubber gas bag attached to the back leg of the absorption pipette remained distended after the liquid had run back to its normal level, and lo, the "mystery" was solved! In passing the gas rapidly from the burette to the pipette, too much pressure was put upon it and some of the gas was forced down through the glass capillary tubes in the front leg of the pipette, bubbled up through the liquid in the back leg and escaped into the gas bag. When the operation was reversed, the pressure in the gas bag was not great enough to force the gas back into the front leg so that it could be drawn back into the burette again. Hence, the water level in the burette seemed to indicate that more carbon dioxide had been absorbed than really was the case. By varying the speed of the manipulation the operator could obtain any indication for carbon dioxide that he desired.

The moral to be drawn from this incident is that unusual results should be viewed with caution even by the man who has obtained them. Before making them public the methods employed and the deductions made should be subjected to careful investigation and analysis.

"It's better to be sure than sorry."

Professor Nicolson's Experiments

Professor Nicolson's experiments with high gas speeds in boilers, an account of which is given elsewhere in this issue, demonstrate that an enormously high rate of heat transfer through the tubes can be attained if the velocity of the gases is great enough. Beyond establishing this fact, however, they add nothing which would seem likely to revolutionize present boiler practice.

In order to prevent the passages around the economizer tubes from becoming choked with soot, it was found necessary to respace the tubes, and after this had been done, the temperature of the gases leaving the economizer rose to two hundred and forty degrees. This is no better than the results attained in everyday operation in well designed plants equipped with economizers; in fact, it is not uncommon in some plants to have the temperature of the gases fall to two hundred degrees. Another significant fact is that Professor Nicolson's experimental

boiler did not show any extraordinary efficiency, such as might be expected from the high rate of heat transmission. True, an efficiency of seventy-nine per cent. was attained on one run, but when the steam required to operate the fan at its high rate of speed, was deducted, the net efficiency fell to sixty-nine per cent.; which is considerably below the results obtained with the best boiler practice.

When it is considered that the goal aimed at in the design of all boilers is to deliver to the water the greatest possible percentage of the heat in the coal, it would seem that the further solution of the problem lies within the furnace.

Gas Poisoning

The narrow escape of an engineer, a few weeks ago, from death by carbon monoxide gas in a producer-gas power plant and the more recent death of a young man and woman in Maryland due to the same gas from a defective stove, bring the subject of gas poisoning strongly to the front. In every producer-gas power plant there is constant danger of fatal "gassing," as our British cousins call it, unless proper precautions have been taken to prevent the escape of carbon monoxide into the building.

The simple suction producer plant is less likely to give trouble in this respect than any other, because the entire system is below atmospheric pressure right up to the engine. But the simple suction plant develops bad operating features as soon as two or more producers are operated in a battery, especially if two or more engines are supplied simultaneously. The induced-draft type of plant comes next in point of freedom from leakage possibilities. The generators, scrubbers and all of the many connections between the generators and the fans are under suction, only the piping between the fans and the engines being under pressure. Moreover, the pressure in this part of the equipment is only a few ounces per square inch and all joints are or should be in plain sight and easily accessible. In such a plant there is much less excuse for gas leakage than there would be for steam leakage throughout the piping of a steam plant.

Even where straight pressure producers are used because of their well known meritorious features, there should not be any great difficulty in preventing the leakage of gas into the building. Of course, there are more points to be protected, but that is merely a routine part of the designing engineer's work.

No matter what the system or the operating conditions, it is just as incumbent upon the builders and erectors to prevent gas leakage as it is upon boilermakers to eschew low-grade steel and lap seams.

Plant or Unit Efficiency

There is a tendency among engineers to judge the economical operation of their plants by the performance of the main engines and boilers. At one plant where the boilers show an efficiency of seventy-two per cent. and the engines a water rate of fourteen and a half pounds per horsepower-hour, it is believed that power is being produced about as cheaply as possible for the size and type of installation; whereas a neighboring plant of similar equipment, in which the boilers show an efficiency of only seventy per cent. and the engines a water rate of fifteen and a half pounds, may, in reality, be producing power much cheaper than the first plant.

Although a determination of the individual efficiencies of the boilers and engines is useful for comparison with other engines and boilers they cannot be taken as a criterion upon which to base the economy of the whole plant. One engine may attain a lower water rate as a result of a half inch higher vacuum, yet the extra power required to produce this additional half inch may more than offset the economy due to the lower water rate. Similarly the other auxiliaries have a direct bearing upon the cost of generating power as do also the labor and fixed charges, and these must be included in the plant efficiency.

The prominence given to the main units is no doubt due largely to the fact that competition among the builders has kept their performances continually in the limelight, and also, in a lesser degree, to the fact that tests of individual units are more common than plant tests.

Concealing the Facts

Accidents are frequently the results of mistakes the careful and intelligent analysis of which will usually bring much to light that will be of great value in showing how the repetition of the mistakes may be avoided.

Refusing to give information and denying access to such information to those whose business it is to search for and find the cause, if possible, is to deliberately seal a source of knowledge to which the public has an unquestionable right, even down to the smallest detail; every factor in an accident which has endangered or destroyed life or property is vitally important to those interested in related lines of work, and they have a moral right to such information. That which is a menace in one situation is also a menace in another, if the conditions are similar, and an error in construction or operation of machinery in one case may be repeated over and over in other localities if detailed information be refused in the first case. Full publicity in every case of accident, therefore, will do much to reduce the number that occur.

Dissatisfaction and even resentment are often if not always shown by all who are in any way connected with an accident if the investigation indicates that it was caused by ignorance or carelessness. This attitude, while perfectly explained on the ground of selfishness and absence of consideration for the safety of others, is wholly inexcusable. That the public has a right to protect itself from polluted water, adulterated food or contagious disease is unquestioned. Power-plant owners and operators do not seem to realize that it has the same right to protect itself from the danger of an accident that ignorance or carelessness may cause.

There is another side of the question that seems to have escaped due attention also. That is the fact that the refusal to give out information concerning an accident will always arouse a natural suspicion that there is a foundation for the uncharitable criticism and gossip which are so general concerning matters of the kind under discussion. It is a good deal better to tell the full truth about an accident than to encourage sinister suspicions and possibly the publication of a garbled story based on partial information and guesswork by a reporter, against which the editor of a periodical is almost always defenseless.

We are hearing so much of late regarding the conservation of our national resources. What about the conservation of time? The average man would be surprised if he realized the amount of time he wastes annually through lack of a systematic way of doing things. System is one of the greatest of time savers.

Balzac said that "Cruelty and fear shake hands together." In steam engineering, ignorance and death walk hand in hand.

A California man who tickled a lion under the chin is now minus three fingers.

A Massachusetts engineer who screwed down a safety valve burst a boiler, killed himself and nineteen others. One act was just as foolhardy as the other.

A certain type of engine runner is disappearing. He is in a class with the old tiddle-de-winks and ping-pong outfits—out of date.

While a man was thawing out a frozen oil pipe, gas, which had accumulated in a receiving tank, was exploded by the torch that was used. The man was blown 150 feet and killed. It pays to be careful.

The man who rigs up an appliance from material on the scrap heap, and makes it work, is a genius compared to the man who makes a nice working drawing of an appliance that will not work.

The majority of explosions occur, not while the boiler is in regular service but while it is being started up. The Pittsfield catastrophe is a case in point.

Flywheel Explosion at Lowell, Mass.

By Joseph King

The 25-ft. flywheel of a twin simple condensing Corliss engine explodes with disastrous results to mill and machinery. The regular speed of the engine was 58 revolutions per minute and the wheel was evidently safe at 80.

Shortly after 7 o'clock Thursday morning, January 26, the 25-foot flywheel of the twin 32x60-inch condensing engine at the No. 7 Boott mill, Lowell, Mass., burst with disastrous results to the engine, machinery and building, but without seriously injuring any of the 150 operatives. The wheel, which weighed approximately 56 tons, was eight feet wide and carried three belts.

As no examination of the engine can be made until the tons of wreckage under which it is buried can be removed, it is not possible to give the initial cause of the accident. That the rupture of the wheel was due to excessive speed is well known, as for some minutes before the final crash the looms on the floors above automatically stopped when the speed increased, and pulleys in various parts of the mill burst from the effects of the high speed.

In the light of the little that is known it is thought that perhaps one of the large belts broke and piled itself up on the floor back of the wheel, either breaking the governor belt or forcing it off the pulley.

The governor, not being furnished with safety devices, allowed the engine to take steam nearly full stroke, which soon drove it to a speed so far above the normal that the wheel exploded.

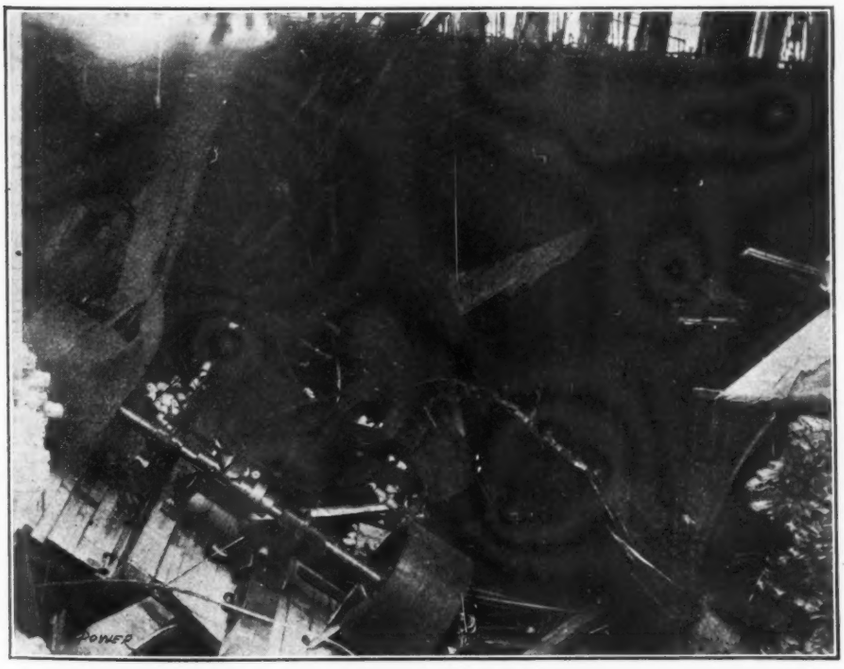


FIG. 1. THE ENGINE LIES BURIED BENEATH THE WRECKAGE

The three belts ran vertically upward quite near the wall and were made to cover a large proportion of the circumference of the flywheel by the use of an idler. As the engine ran "under," it is quite within the limits of the possible that a broken belt following the direction of rotation of the wheel would catch on the floor and pile up between the engine frames and render the governor inoperative.

The engine ran at 58 revolutions per minute, which was only about two-thirds of the safe speed for the comparatively modern design of this wheel.

The fragments of the rim tore through four floors and the wall of the building, making an opening about 50 feet wide, around and over the edges of which hung the ends of machines and shafting supported by the tightened belts and lag bolts. One section of the wheel, weighing nearly 900 pounds, was thrown through the roof and landed on the top of the building where it remains; while another piece went up through the second floor and lay close to the edge of the hole.

Although it is true that probably nothing is certainly known of the cause of the accident, a great deal of street talk and the newspaper reports give the impression that from the time the increase in speed was noticed to the final crash, several minutes elapsed, and that the engine might have been stopped, as the operatives had plenty of time to escape from danger.

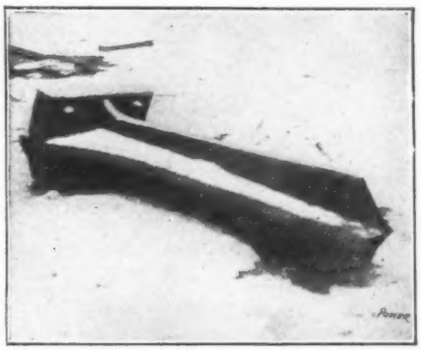


FIG. 2. PIECE OF WHEEL ON ROOF AND HOLE THROUGH WHICH IT CAME

During this time, it is reported that the engineer, a new man, was seeking the master mechanic to get permission to stop the engine.

It is estimated that the damage will exceed $50,000, $30,000 of which is covered by insurance. Only one operative, a young Greek girl, was hurt in any way, and she only slightly by running against one of the machines.

Heating and Ventilating Convention

The seventeenth annual meeting of the American Society of Heating and Ventilating Engineers was held on January 24, 25 and 26 at the Engineering Societies building, New York City.

The following papers were presented: "Pipe Line Design for Central Station Heating," by B. T. Gifford; "The Value of Good Ventilation," by Prof. Severance Burrage, Lafayette, Ind.; "Standards of Ventilation," by Dr. W. A. Evans, Chicago; "Ventilation of the Capitol, Washington, D. C.," by Nelson S. Thompson. In addition to these papers a report was submitted by the committee on "Effect of Air Leakage and Wind Velocities on Heating Guarantees." A report was also submitted by the committee on "The Rating of Heating Boilers."

Mr. Gifford's paper on "Pipe Line Design for Central Station Heating" will be printed in abstract in next week's issue.

Value of Good Ventilation

Professor Burrage indicated in his paper on the above topic that the value of good ventilation was found in the good health and high efficiency of the people occupying well ventilated buildings. One of the most important predisposing factors in the spread of tuberculosis and pneumonia is bad air. Not only is health greatly improved and the power of resistance of the body against disease greatly increased by breathing pure air, but much more efficient work can be done by those who study and work in well ventilated rooms.

Standards of Ventilation

Doctor Evans showed that the standard of ventilation must be complex because it must depend on many factors such as the different qualities of air and the different methods of handling air. If a building is so located that it gets lots of sunshine in its interior the standard of ventilation may, possibly, be lowered 20 per cent. while that for a basement or cellar where sunshine seldom enters must be raised 20 per cent. In a hospital the standard must be high because the general degree of health is low. Thus, the standard is influenced by the physical character of the building, the use to which it is put, the class of people occupying it, etc.

After all such factors have been taken into account, the standard of ventilation must provide restrictions as to the dust content in the air, the humidity, the temperature, the carbon dioxide content, odors, the frequency of air change, air current and bacterial conditions.

Ventilation of the Capitol, Washington, D. C.

The paper on this topic consisted mainly of a description of the methods employed and the results obtained during tests to ascertain the quantities of the various constituents, chiefly carbon dioxide, of the air in the Capitol building.

The system of ventilation used in the Senate chamber and that of the House of Representatives is of the up-draft type. Air is admitted by numerous floor openings, and is drawn out through ducts in the ceiling by exhaust fans. The conclusion drawn from the tests is that while the quantities of air circulated are sufficient for excellent ventilation, the distribution of the air is poor and that the system employed is, consequently, unsuitable.

Effect of Air Leakage and Wind Velocities on Heating Guarantees

The report of the committee on the above consisted of a few specific examples in the form of test results obtained at the Harvard Medical College buildings and at the gymnasium buildings at Michigan University.

Due to the dirth of data available to the committee it was impossible to draw any definite conclusions. The committee urged that a future, larger committee be created to acquire more data on these important factors in heating requirements.

Rating of Heating Boilers

The committee on the above recommended that a square foot of direct heating surface be used as the unit of rating, based upon the assumption that a square foot of direct steam heating surface gives off 250 B.t.u. per hour, and that a square foot of direct water heating surface gives off 150 B.t.u. per hour. It was recommended that the rating of heating boilers be based on the number of square feet of steam radiation or water radiation surface having heat radiating values as before stated and that the statement of rating be accompanied by a statement of the rate of combustion and the efficiency of the boiler.

The following were elected to office for 1911: R. P. Bolton, President; J. R. Allen, first vice-president; A. B. Franklin, second vice-president; W. W. Macon, secretary and W. G. Scollay, treasurer, reëlected.

Industrial Accidents

Industrial accidents in the United States take an annual toll of life and limb far exceeding the killed and wounded of several great military campaigns. The statistics given by the *Bulletin* of the Bureau of Labor for 1908, which must be regarded as incomplete because of the failure to report fully these accidents, show a yearly mortality of between 30,000 and 35,000 adult wage earners alone, and the nonfatal injuries inflicted will roll up the total by at least an additional 2,000,000. These and other arresting statements are made by John Calder, manager of the Remington Typewriter Works, Illion, N. Y., who will, at the New York monthly meeting of the American Society of Mechanical Engineers, 29 West Thirty-ninth street, New York, Tuesday evening, February 14, present a brief for the mechanical engineer and the prevention of accidents. Much, Mr. Calder believes, can be accomplished by a movement on the part of the profession which has to deal so largely with the planning and working of industrial machinery. Prevention, not cure, is the theme of the paper, which analyzes the causes of those accidents regarded as preventable and describes various devices for guarding equipment and processes, drawn chiefly from the writer's experience in plant management. Mr. Calder considers that one-third of the present rate of mortality can and should be eliminated by such devices. The National Civic Federation and the Industrial Safety Association, which have already done much to arouse public sentiment along this same line, will be represented at the meeting and engage in the open discussion which will follow the presentation of the paper. Both before and after the meeting the American Museum of Safety, also located in the Engineering Societies building, will open its exhibit to the public.

Under the head of safeguarding, the author has many interesting views of equipment and machinery, showing the use of such devices on gears, steam turbines, lathes, cotton carders, rolling-mill engines, transmission tubes, belts, etc. He also takes up in detail especially dangerous machines and processes which present difficult safeguarding problems for the engineer.

Advance copies of the paper may be secured for review upon application to the secretary, Calvin W. Rice.

Water Power in British Columbia

According to Consul Frank C. Denison, in the *Daily Consular and Trade Reports*, a plant for the generation of electrical power by water has been successfully inaugurated by a company of Americans at the Bull river falls, 13 miles due west of Fernie. At this point a fall of 273 feet has been obtained by the construction of a flume 9000 feet long, which takes water from the river above the falls and returns it below. A head of 273 feet with a flow of 462 cubic feet of water per second has been obtained. The flume, constructed of wood and built upon a rock foundation, is 30 feet wide by 7½ feet deep at the intake. The width is reduced to 16 feet within the first thousand feet, this width being kept to the end of the flume. The estimated horsepower that can be utilized is 12,600.

The company is now preparing to install the penstock, which is to be of steel, 9 feet in diameter, and will rest upon bed rock the whole length, at an angle of 30 degrees. The foot of the stock will rest upon a natural bed rock, and a tee-shaped cross pipe will be placed at the end of the stock in which the wheels will be placed; three wheels of 4200 horsepower each will be utilized as the demand for power develops.

Within a radius of 30 miles there are now in operation steam plants with an aggregate of 23,650 horsepower. Some of this power is used by sawmills, which will continue to employ steam on account of the cheapness of the mill waste used as fuel, but it is expected that many mining and smelting plants within reach of this new plant will discard steam for electrical power.

Within this radius there is available undeveloped water power to the extent of 30,000 horsepower, the greatest single power being at Elko, on the Elk river, 20 miles south of Fernie. This estimate does not include the possible power to be developed by damming the different mountain streams in their courses, but is confined to the power available at the various natural falls on larger streams.

New Power House Equipment

What the inventor and the manufacturer are doing to save time and money in the engine room and power house. Engine room news

The Merrick Conveyer Weightometer

This device is for the purpose of recording the weight of coal transported on a belt or bucket conveyer.

It consists of a pair of weighing levers *L*, Fig. 1, a steelyard or beam *B*, similar in principle to those of the usual platform scale, but of special design so that a short section or portion of the conveyer can be suspended from the weighing levers.

The weight of the load on this suspended portion of the conveyer, regardless of its distribution, is at any instant automatically counterbalanced by the buoyancy of a cylindrical iron float suspended from near the long end of the weighing beam and partially immersed in a bath of mercury. Any increase or decrease of load on the levers will either raise or lower the float in the mercury until the loss or gain in buoyancy compensates for the variation in load. Fig. 2 shows how the weightometer is placed over a belt conveyer.

The function of this float is to insure that the movement of the beam from its zero position, or position when the conveyer is empty, be proportional to the weight of material at any instant on the suspended portion of the conveyer.

At the extreme end of the weighing beam is connected a totalizing mechanical integrator, which derives its other factor from the travel of the conveyer by means of suitable gearing from a band pulley on the return belt or a sprocket wheel if on a bucket conveyer.

This integrator continuously totalizes the product of two quantities, one proportional to the weight of material suspended and the other to the travel of this material. The result therefore represents the total weight of material and is plainly indicated by a register in units and tenths of units of either a short ton, long ton or metric ton.

For cases where the material handled adheres to the conveyer in a varying amount, an attachment is added that automatically counterbalances the variable weight of the empty conveyer. This avoids frequent adjustment to meet the changes in the weight of the empty conveyer and material that may adhere thereon.

This integrator consists of an aluminum disk, Fig. 3, around the periphery of which are mounted rollers that are free to revolve, and have their axes tangential to the edge of the disk, and form practically a continuous annular roller which cannot move around the disk which is fixed on a shaft that revolves in bearings on the frame. This frame is mounted with a bearing at either end so that it can rotate about an axis coincident with the plane of the disk and at right angles to the axis of the disk. On one end of this frame is an arm the extremity of which is connected by a link

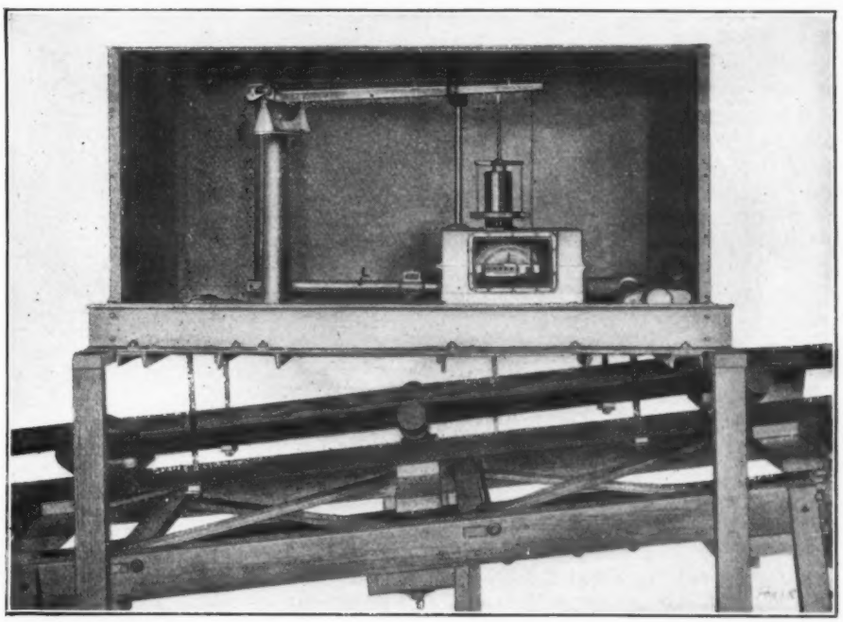


FIG. 1. VIEW OF WEIGHTOMETER ON BELT CONVEYER

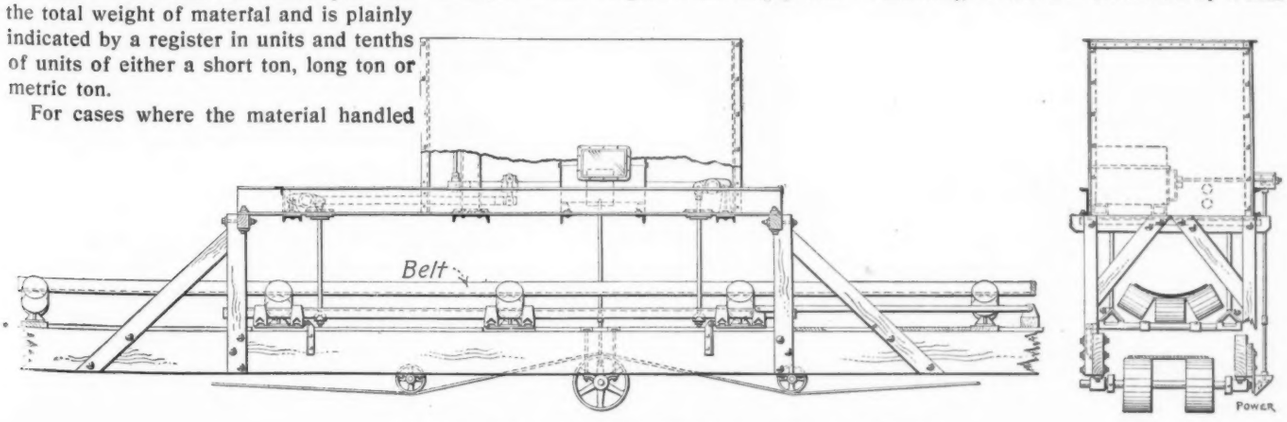


FIG. 2. SIDE AND END ELEVATION OF WEIGHTOMETER

to the long end of the beam. Thus any movement of the beam, caused by an increase of the load on the belt, tilts the frame through an angle whose sine is proportional to the vertical movement of the float, and again proportional to the load on the suspended portion of the conveyer.

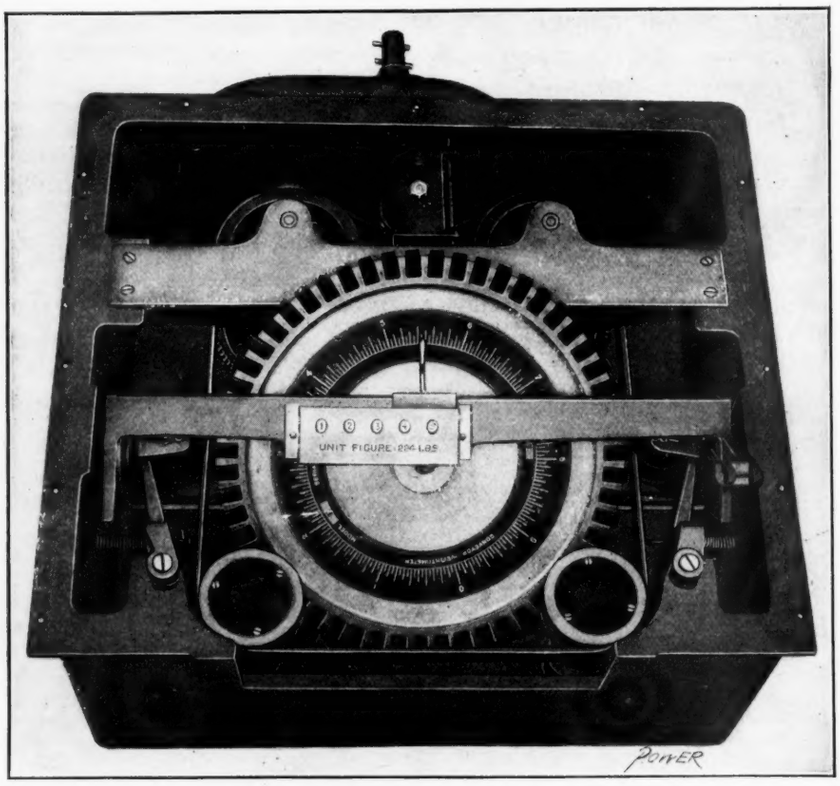


FIG. 3. DETAILS OF THE INTEGRATOR

Four pulleys guide a small endless belt around the disk and touching the rollers thereon at two points diametrically opposite and on the axis of the frame.

Pressure rollers behind the belt keep the belt and disk rollers in contact. A weighted take-up pulley assures an even tension in the belt and takes care of any stretch. The two upper pulleys are geared together and are driven by means of miter gears from a band pulley under the return belt as shown in Fig. 2. The integrator belt thus travels at a speed proportional to that of the conveyer.

So long as the plane of rotation of the roller on the recording disk is parallel to the direction of the integrator belt, the motion of the latter will only affect it to the extent of revolving the roller on its own axis. This condition corresponds with the zero position of the beam or when there is no load on the conveyer. If, however, the beam is deflected by the loading of the belt, the frame and recording disk will be correspondingly tilted. This will incline the axes of the roller with respect to the integrator belt. Then, besides rotating them, the belt will push the rollers sideways across its face at a rate proportional to their inclination. As the rollers cannot slide on the disk they will rotate it around its axis. Consequently the speed of rotation of the disk is proportional to the deflection of the beam, the movement of the float or the load on the conveyer. The amount of its motion is thus a measure of the weight of material carried by the conveyer during the period of observation. Thus the revolution counter mounted on the disk shaft will record and totalize the weight carried in any units for which the mechanism is designed.

A glance at the dial when the conveyer is running empty will determine whether the dead weight of the idlers, etc., plus the weight of the belt or buckets is correctly balanced so that the net weight of the material is recorded. Should the dial remain stationary or move back and forth between two constant limits of travel the adjustment is correct. Should the dial make a plus or minus gain the proper balancing is done by means of a weight on the steelyard. This weight is carried on a screw and is similar to that on the ordinary platform scale, as turning the screw moves the balance weight.

A magnetic counter is furnished, if desired, that will duplicate the reading of the scale register in the engineer's office or at any other point distant from the scale itself and present the record right at hand. This is accomplished by a pin on the recording dial closing a circuit, thereby causing an electrical current to pass through a set of coil magnets, the armature of which is attached to a link connecting to the counting device which is located in the engineer's office.

All of the shafts within the casing and integrator turn either in ball bearings or special self-lubricating bushings, but no matter how much looseness there may be in the latter due to wear, the accuracy is not impaired as the travel of the small belt is not reduced. The speed of the integrator belt is only about 30 feet per minute and therefore the pulleys and rollers on the disk rotate slowly, resulting in but very slight wear after long service. Because of the large diameter of the disk, the wear of the rollers on their pins causes only an almost inappreciable error.

As all parts are inclosed in a removable sheet-iron casing, Fig. 4, unauthorized persons are prevented from having free access to the apparatus, and the dust and dirt always present around conveyers, which would quickly impair the efficiency of any exposed mechanism, is thus kept away from the working parts of the device.

This weightometer is manufactured by Herbert L. Merrick, Passaic, N. J.

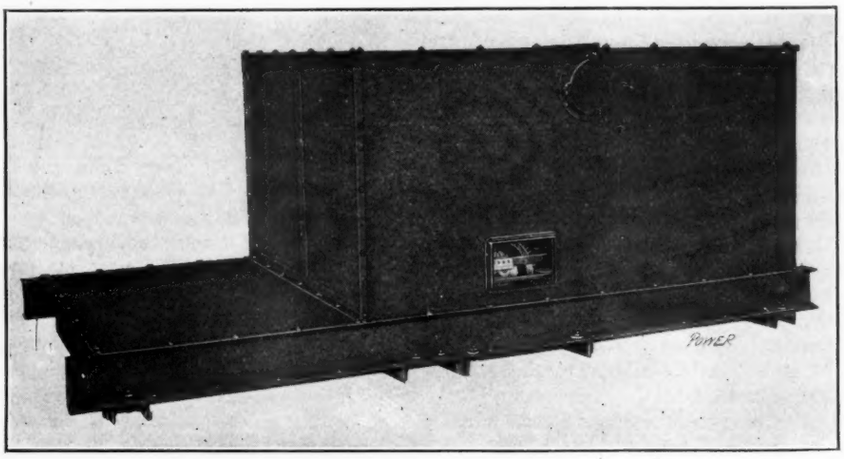


FIG. 4. WEIGHTOMETER WITH CASING IN PLACE

Correction Note

In the issue of December 20, mention was made of the flow past the seat of the Nelson blowoff valve. One of the special features of this valve is that it has no seat, as may be readily seen from the cut which accompanied the description. In the same article an older form of the Powell blowoff was shown. The latest or "cyclone" self-cleaning valve will be described in the near future.

Mechanical Engineers Give Reception to Captain of "Celtic"

An informal committee of the 1910 transatlantic party of the American Society of Mechanical Engineers entertained Capt. A. E. S. Hambelton, of the "Celtic," at luncheon on January 17 at the Engineers' Club, New York City.

The "Celtic" was the ship upon which the mechanical engineers went to England last summer at the time of their joint meeting with the Institute of Mechanical Engineers at Manchester, Eng.

The luncheon to Captain Hambelton was given as a token of the high esteem in which he is held by the members of the party.

Prof. F. R. Hutton, as director of ceremonies, extended the felicitations of the members to the captain in the shape of a wish that he may continue to meet with the success he so well deserves.

Those who attended are: F. R. Hutton, Capt. A. E. S. Hambelton, Jesse M. Smith, Leonard Waldo, F. B. Gilbreth, John Platt, C. E. Davis, S. L. Moore, G. M. Bond, L. C. Marburg, Augustus Smith, G. A. Orrok, C. W. Rice, E. D. Meier, C. H. Corbett and H. B. McCreery.

Boiler Flue Blows Out

Another boiler accident in Missouri emphasizes the necessity of rigid boiler-inspection laws in that State. It is reported by Albert Dedrick that on January 20, several flues in an old boiler in a flour mill at Union Star, Mo., failed. The engineer had a narrow escape from death, having only a few minutes previous stepped to the rear of the boiler to make some minor repairs. One flue went out through the front flue sheet and landed several hundred feet away. As luck would have it, no one was hurt. An examination showed that the boiler was old and the flues were in such condition that they should have been replaced long ago.

Pabst Brewing Company Wins Boiler Explosion Suit

In the case of the Pabst Brewing Company versus the Hartford Steam Boiler Insurance and Inspection Company, just tried in Milwaukee before Judge A. T. Sanborn, of the western district of Wisconsin, the jury brought a verdict in favor of the plaintiff for $98,400 with interest from December 1, 1909. The case was immediately appealed. Full particulars will be given in a later issue.

BOOKS RECEIVED

AUTOMOBILE MECHANICIANS CATECHSIM. Published by Frederick J. Drake & Co., Chicago, Ill. Leather cover; 110 pages, 4¼x6½ inches; illustrated plates; indexed. Price, $1.25.

THE MECHANICAL WORLD ELECTRICAL POCKETBOOK FOR 1911. Published by Emmott & Co., Ltd., Manchester, Eng. Cloth; 208 pages, 3¾x6 inches; 68 illustrations; tables. Price, sixpence.

Valuable Reference to Technical Press

The International Institute of Technical Bibliography is publishing a monthly index to the world's technical press, covering technical periodicals, new books and the proceedings of learned societies. The first volume has now been completed. To create an English and American center, the institute has recently founded a special branch in London, 57 Chancery lane, whence the English and American editions are sent out. The value of the publications may be best explained by reprinting an appreciation of them by E. Wyndham Hulme, chief librarian of the English patent office, which appeared in the *Library Association Record.*

"By some freak of fortune practical England has for the last half century stood out as the champion of the indexing of the periodical literature of pure science, while to philosophic Germany belongs the credit of having maintained for the same period an annual index of the corresponding literature of the applied sciences. Not many years ago the Royal Society's *Catalogue of Scientific Papers* was handed over to the control of an International Council with regional bureaus, and today we have to chronicle a similar reorganization of the "Poole" of technical periodical literature, viz., the *Repertorium* of the imperial patent office of Berlin. This hardy annual has in its turn been transferred to an International Institute of Technical Bibliography, organized on lines similar to those of the International Council. The first step taken has been to transform the publication into a monthly, and to extend it by the inclusion of book notices. From the beginning of the past year the index has been published in six sections dealing respectively with 1, mechanical; 2, civil; 3, electrical engineering; 4, mining and metallurgy; 5, applied chemistry; 6, matter not included in the preceding sections. A further section dealing with the naval, military and aëronautical sciences has also appeared recently. These monthly sectional indexes or *Abstracts,* as they are termed, will be consolidated at the end of each year in one general alphabet. The first of these annual publications for the year 1909 has just appeared in two volumes. The classification of the decreased *Repertorium* was on dictionary principles, the title, headings and index being in German, English and French, while the entries were compiled in the language of the articles indexed. The new publication follows closely on the old lines, except that the monthly sections have their headings arranged in class order, with a synopsis of the classification prefixed to each number.

"The life of the German edition is practically guaranteed by subscriptions from the state department, professional societies and manufacturing firms of Germany. But the fate of the English edition must be regarded as conditional upon the support received in these countries."

SOCIETY NOTES

The ninth annual reception and banquet of the combined associations of the National Association of Stationary Engineers of Greater Pittsburg was held on Thursday evening, January 26. Over 400 of the members and guests, including both sexes, gathered about the tables in the large dining hall of the Monongahela house and enjoyed an appetizing dinner.

After the banquet was served, an entertainment was given by the Duquesne quartet, J. C. Usher, Crandall Packing Company; Billy Murray, Jenkins Brothers; Frank Corbett, Consolidated Valve Company, and Jack Armour, of POWER. Dancing followed and concluded a most enjoyable and successful occasion.

With the new year the National Electric Light Association has taken another leap forward in membership and on January 21 crossed the 6500 line. This is a gross gain of over 1500 since the St. Louis convention and a net gain of about 1250. The Canadian Electrical Association voted recently to affiliate with this body and this will also bring a large accession; while new company sections are being formed in Pittsburg, Allegheny City, Scranton, Connellsville, Penn., and other cities. H. H. Scott, the chairman of the membership committee, estimated that 7000 members will be enrolled by the end of January and that the number may easily be 8000 by the next annual convention in June. Fifteen months ago the membership was slightly over 3000. A number of smaller central stations are included in the new membership.

Pete Blowoff talks a heap with his mouth. His boss told 'im thet they wuz thinkin' uv puttin' in a hot-air ingin so ez he cud furnish th' fuel fer runnin' it.

Cleveland No. 5 Honors Past President William Powell

It has been the practice of the National Association of Stationary Engineers in recent years to present the retiring national past president with a past officer's jewel. At the last convention it was voted to present such badges to the living past presidents of the association who had not thus been honored.

On Saturday evening, January 28, Cleveland Association No. 5, of which Past National President William Powell is an old and honored member, held a special meeting for the formal presentation of this jewel.

There were present Past National Presidents John W. Lane and Robert E. Ingleson, many State and subordinate officers and State examiner of engineers Haswell. There were large delegations from the two other Cleveland associations, as well as a big representation from the other Ohio associations, justifying the claim of Chairman J. E. Radigan that this was the largest and most important gathering of Ohio engineers that has been held outside of a State convention.

After the adjournment of the regular meeting, the company proceeded to the dining hall, where Mr. Powell was seated at the head of the table and presented with the jewel of past president of local association No. 5, and then with the national emblem. Mr. Powell was visibly affected by this expression of appreciation of his past services, and in his speech of acceptance reviewed in an interesting way the conditions of the engineer before the organization of the National Association of Stationary Engineers, and some of the earlier activities of the association.

Brief remarks from many others in attendance enlivened the proceedings and extended the program well into the night.

NEW INVENTIONS

Printed copies of patents are furnished by the Patent Office at 5c. each. Address the Commissioner of Patents, Washington, D. C.

BOILERS, FURNACES AND GAS PRODUCERS

FURNACE FOR WATER-TUBE BOILERS. Alfred Smallwood, London, Eng. 981,699.

WATER-GAS PRODUCER. Bernhard Spitzer, Frankfort-on-the-Main, Germany, assignor to the Corporation of Dellwik-Fleischer Wassergas-Gesellschaft, m.b.h., Frankfort-on the-Main, Germany. 981,708.

WATER-TUBE BOILER. Darwin Almy, Providence, R. I. 982,198.

STEAM GENERATOR. Jean Van Oosterwyck, Liege, Belgium. 981,722.

POWER PLANT AUXILIARIES AND APPLIANCES

COMBINED FEED WATER HEATER AND GRATE. Gustav Beyer, Fort Sill, Okla. 981,609.

BOILER-CLEANING DEVICE. Laurence Smith and George D. Mullihan, Webb City, Mo. 981,701.

CRUDE-OIL BURNER. John A. Scott, Joseph F. Grubbs, and John E. Goss, Oklahoma, Okla. 981,801.

HOSE COUPLING. Samuel R. Lockhart, Buna, Tex., assignor of one-half to Stephen E. Milsted, Buna, Tex. 981,866.

FEED-WATER HEATER. Edward T. Turner, Dayton, Ohio. 981,901.

METALLIC PACKING. William M. Brooks, New York, N. Y., assignor, by mesne assignments, to Premier Engineering and Manufacturing Company, New York, N. Y., a Corporation of Delaware. 981,912.

PIPE UNION. Josiah Boone Austin, San Diego, Cal. 982,028.

GATE VALVE. Adoniram J. Collar, Yreka, Cal. 982,036.

VALVE. George Wilkinson, Philadelphia, Penn. 982,108.

VALVE. Henry R. Adams, Bridgeport, Conn. 982,109.

OIL CAN. Madel T. Axelton and William C. Axelton, Graettinger, Iowa. 982,114.

PRESSURE REGULATOR. Tom William Brown, London, England, assignor of one-half to Frederick Charles Tilley, London, England. 982,123.

OIL BURNER. Henry N. Kellar, Kiefer, Okla. 982,141.

OIL BURNER. Charles W. Wright, Hobart, Okla. 982,167.

ROD PACKING. Thomas A. Johnston, Chadron, Neb., assignor of one-fourth to Thomas L. Finley, Long Pine, Neb. 982,182.

PRIME MOVERS

INTERNAL COMBUSTION ENGINE. Eldridge W. Stevens, Baltimore, Md. 981,811.

ROTARY ENGINE. Robert Ford Courtenay Keats, Portsmouth, Eng. 981,862.

OSCILLATING WATER MOTOR. Robert C. Smith, Oak Park, Ill. 981,889.

INTERNAL COMBUSTION ENGINE. Clark Sintz, New Orleans, La., assignor of fifty-one one-hundredths to William A. Gordon, New Orleans, La. 981,952.

INTERNAL COMBUSTION MOTOR. Clyde J. Coleman, New York, N. Y., assignor to Rockaway Automobile Company, Rockaway, N. J., a Corporation of New Jersey. 981,978.

MOTOR. Charles E. Godlove and James L. Van Nort, St. Louis, Mo.; said Van Nort assignor, by mesne assignments, to said Charles E. Godlove, St. Louis, Mo. 981,995.

ROTARY ENGINE. Clarence E. Clapp, Buffalo, N. Y. 982,035.

ROTARY ENGINE. Edward Hager, Buffalo, N. Y. 982,054.

WATERWHEEL MECHANISM. Thomas A. Macdonald, Clifton, N. J., assignor, by direct and mesne assignments, to Macdonald Hydraulic Power Company, a Corporation of New Jersey. 982,079.

CURRENT MOTOR. James H. Martin, Springfield, Mo. 982,154.

ELECTRICAL INVENTIONS AND APPLICATIONS

ELECTRIC SWITCH. Howard R. Sargent, Schenectady, N. Y., assignor to General Electric Company, a Corporation of New York. 981,692.

ELECTRIC LOCOMOTIVE. Wm. Schaake, Pittsburg, Penn., assignor, by mesne assignments, to Westinghouse Electric and Manufacturing Company, East Pittsburg, Penn., a Corporation of Pennsylvania. 981,799.

ELECTRIC CONTROLLER. Arthur C. Eastwood, Cleveland, Ohio, assignor to the Electric Controller and Manufacturing Company, Cleveland, Ohio, a Corporation of Ohio. 981,847.

ALTERNATING-CURRENT POTENTIAL SWITCH. David Larson, Yonkers, N. Y., assignor to Otis Elevator Company, Jersey City, N. J., a Corporation of New Jersey. 981,930.

MOTOR CONTROL. William N. Dickinson, Jr., New York, N. Y., assignor to Otis Elevator Company, Jersey City, N. J., a Corporation of New Jersey. 982,041.

ELECTRICAL SYSTEM FOR THE SUPERVISION OF WATCHMEN. Albert Goldstein, New York, N. Y., assignor to International Electric Protection Company, a Corporation of New York. 982,052.

ALTERNATING-CURRENT MOTOR CONTROL. John D. Ihlder, New York, N. Y., assignor to Otis Elevator Company, Jersey City, N. J., a Corporation of New Jersey. 982,067.

SOLENOID-OPERATED SWITCH. Henry L. Smith, Schenectady, N. Y., assignor to General Electric Company, a Corporation of New York. 982,100.

POWER PLANT TOOLS

WRENCH. Harry Horsman, Jamestown, Cal. 982,064.

RATCHET WRENCH. Walter Gartze, Solingen-Mangenberg, Germany. 980,626.

WRENCH. Charles Andrew Hartvigsen, Salinas, Cal. 980,632.

WRENCH. Joseph T. Humphries, Oakville, Tex. 980,786.

ENGINEERING SOCIETIES

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Pres., Col. E. D. Meier; sec., Calvin W. Rice, Engineering Societies building, 29 West 39th St., New York. Monthly meetings in New York City.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Pres., Dugald C. Jackson; sec., Ralph W. Pope, 33 W. Thirty-ninth St., New York. Meetings monthly.

NATIONAL ELECTRIC LIGHT ASSOCIATION

Pres., Frank W. Frueauff; sec., T. C. Martin, 31 West Thirty-ninth St., New York. Next meeting in New York City, May 29 to June 3.

AMERICAN SOCIETY OF NAVAL ENGINEERS

Pres., Engineer-in-Chief Hutch I. Cone, U. S. N.; sec. and treas., Lieutenant Henry C. Dinger, U. S. N., Bureau of Steam Engineering, Navy Department, Washington, D. C.

AMERICAN BOILER MANUFACTURERS' ASSOCIATION

Pres., E. D. Meier, 11 Broadway, New York; sec., J. D. Farasey, cor. 37th St. and Erie Railroad, Cleveland, O. Next meeting to be held September, 1911, in Boston, Mass.

WESTERN SOCIETY OF ENGINEERS

Pres., J. W. Alvord; sec., J. H. Warder, 1735 Monadnock Block, Chicago, Ill.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA

Pres., E. K. Morse; sec., E. K. Hiles, Oliver building, Pittsburg, Penn. Meetings 1st and 3d Tuesdays.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.

Pres., Prof. J. D. Hoffman; sec., William M. Mackay, P. O. Box 1818, New York City.

NATIONAL ASSOCIATION OF STATIONARY ENGINEERS

Pres., Carl S. Pearse, Denver, Colo.; sec., F. W. Raven, 325 Dearborn street, Chicago, Ill. Next convention, Cincinnati, Ohio.

AMERICAN ORDER OF STEAM ENGINEERS

Supr. Chief Engr., Frederick Markoe, Philadelphia, Pa.; Supr. Cor. Engr., William S. Wetzler, 753 N. Forty-fourth St., Philadelphia, Pa. Next meeting at Philadelphia, June, 1911.

NATIONAL MARINE ENGINEERS BENEFICIAL ASSOCIATIONS

Pres., William F. Yates, New York, N. Y.; sec., George A. Grubb, 1040 Dakin street, Chicago, Ill. Next meeting at Detroit, Mich., January, 1912.

INTERNAL COMBUSTION ENGINEERS' ASSOCIATION.

Pres., Arthur J. Frith; sec., Charles Kratsch, 416 W. Indiana St., Chicago. Meetings the second Friday in each month at Fraternity Halls, Chicago.

UNIVERSAL CRAFTSMEN COUNCIL OF ENGINEERS

Grand Worthy Chief, John Cope; sec., J. U. Bunce, Hotel Statler, Buffalo, N. Y. Next annual meeting in Philadelphia, Penn., week commencing Monday, August 7, 1911.

OHIO SOCIETY OF MECHANICAL ELECTRICAL AND STEAM ENGINEERS

Pres., O. F. Rabbe; acting sec., Charles P. Crowe, Ohio State University, Columbus, Ohio. Next meeting, Youngstown, Ohio, May 18 and 19, 1911.

INTERNATIONAL MASTER BOILER MAKERS' ASSOCIATION

Pres., A. N. Lucas; sec., Harry D. Vaught, 95 Liberty street, New York. Next meeting at Omaha, Neb., May, 1911.

INTERNATIONAL UNION OF STEAM ENGINEERS

Pres., Matt. Comerford; sec., J. G. Hannahan, Chicago, Ill. Next meeting at St. Paul, Minn., September, 1911.

NATIONAL DISTRICT HEATING ASSOCIATION

Pres., G. W. Wright, Baltimore, Md.; sec. and treas., D. L. Gaskill, Greenville, O.

Moments with the Ad. Editor

A department for subscribers edited by the advertising service department of Power

In the *Saturday Evening Post* not long ago there appeared a story describing the struggle of a number of Mississippi planters to keep the levee, which protected their property, from breaking.

Day and night they patrolled the embankment, watching for leaks.

Whenever a soft spot was discovered, where the rising water oozed through, the alarm was raised and help was immediately sent to strengthen the weak section. Sacks of earth were thrown in and then, just as the repair was completed, a fresh cry would be raised from some point further up or down the line and reinforcements would be rushed to the new danger point.

Relaxation meant the wiping out of lives and property.

Across the river, where the banks of another plantation ran down to the water's edge, the same scene was being enacted. And as they toiled, each group of workers watched the other, secretly hoping that the opposite bank would go first.

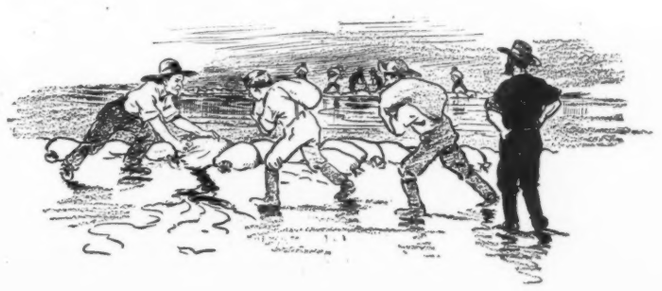
As a matter of fact both levees held. Close watchfulness and sacks of sand saved the day.

If the author of this story had tried to illustrate a great advertising truth he could not have furnished us with a better example for a simile—

In the power plant field, as in other lines, one of the secrets of success is watchfulness—

Watchfulness against excessive power costs—

Watchfulness against wasted material and effort—



Watchfulness against the hundred and one little profit leaks in the plant, which, if allowed to continue, will swell to serious proportions.

The safe, efficient and economical running of a power plant is the levee which every progressive engineer should constantly patrol. When he finds a weak spot he should strengthen it himself, or if the breach is too big he should send straight to "headquarters "for reinforcements in the shape of some device or piece of equipment which will mend the break and render that point stronger than ever.

And here is where the intelligence and resourcefulness of the engineer comes in.

To the Southern planters in the story all bags of sand are alike and will accomplish the desired results equally well, but the engineer knows that each sign of trouble in his plant, or attempt at betterment, requires different treatment.

The only way an engineer can keep up to date on the improvements being made in power plant machinery is by reading his technical paper and by studying the various advertised articles.

Across the bank is the other engineer, guarding his own levee and hoping that if something breaks it won't be on his side.

It's a case of the weakest going first. The strongest power plant man is the one who not only detects the soft spots in his embankment, but who possesses a ready and accurate knowledge of what reinforcements to shove into the breach.

Guard your levee!

BUSINESS ITEMS

The Power and Mining Machinery Company has removed its Chicago office from the First National Bank building to 825 Old Colony building, corner Dearborn and Van Buren streets.

The York Manufacturing Company, York, Penn., manufacturer of ice-making and refrigerating machinery, reports the receipt of 67 orders from November 22 to January 24; these orders aggregate 2959 tons of refrigeration.

The Drop Forging Company, of New York, manufacturer of Spartan chain-pipe wrenches and other special drop forgings, has recently purchased from the Bergen foundry the site and buildings located at the corner of West Side avenue and Fisk street, Jersey City, N. J. The plant has a frontage on West Side avenue of 308 feet and 210 feet on Fisk street.

The Richmond, Va., waterworks saved $310 by repairing a 10-inch main steam line carrying 125 pounds pressure with six Simplex pipe-joint clamps costing $90 instead of altering the line, which would have cost about $400. These clamps were installed on an average of about a year ago, and Chas. Burkart, assistant superintendent, is much pleased with the results thus shown.

The Allis-Chalmers Company has announced the appointment of E. T. Pardee, formerly manager of its Boston office, as manager of its power and electrical department. Mr. Pardee is well qualified for this position, having been actively connected with the selling of power and electrical apparatus during most of his business life. Mr. Pardee will be succeeded as manager of the Boston office by T. J. Lynch, who, for the past seven years, has been manager of the Toronto office of Allis-Chalmers-Bullock, Ltd. Prior to that he had been connected with the construction department of Allis-Chalmers Company.

The Dyna-Como Company, Inc., formerly of 35 Hartford street, Boston, Mass., met with a severe loss through fire on December 4. Its factory was almost entirely destroyed. Its large stock of gaskets, ready for shipment, was rendered worthless. The fire was supposed to have started by a short circuit in the electric-light wiring. This company is now located permanently at 11 Chardon street, Boston, where it has installed a large amount of new machinery, necessitated by the increased demand for its gaskets and the large number of orders which it has on hand.

The Westinghouse Electric and Manufacturing Company has recently closed a contract with the Universal Portland Cement Company for motors to operate its No. 6 plant, at Buffington, Ind. The motors will be of the "MS" mill type, having characteristics specially suitable for cement-mill work, and they will operate on a 3-phase, 25-cycle, 440-volt circuit. The sizes range from five horsepower to 200 horsepower, and the aggregate capacity is 11,500 horsepower. This plant will be the largest in the United States, having a daily capacity of approximately 12,000 barrels, and will be electrically operated throughout, the various drives being of the latest development for cement-mill work.

The Wm. Powell Company, Cincinnati, Ohio, is regularly shipping the Powell model Star valve on the contract with the Isthmian Canal Commission for all the globe and angle valves up to and including 4 inches, for use in the construction work at Panama. This valve was selected by the board of engineers in competition with valves of various other manufacturers as the best valve for the service desired. No change in construction or the metal formula used was required by the Commission to conform to the specifications and this valve is precisely the same as it is supplying to every user. This valve has been used by the Government in many of its service branches and has been shipped in varying quantities from a carload which was sent to the Philippines to the smaller quantities ordered for emergency service.

NEW EQUIPMENT

Holland, Mich., will install a pumping system.

Newcastle, Ind., will install an auxiliary water plant.

The city of Sarasota, Fla., voted to issue bonds for waterworks.

The Rogers (Ark.) Ice and Cold Storage Company is erecting a plant.

The Charlton Mill, Fall River, Mass., is building a new boiler house.

New Bedford, Mass., will make improvements in its water system.

The city of Rusk, Tex., will vote on issuance of bonds for waterworks.

The city of Rockford, Ill., is considering site for a new pumping station.

HELP WANTED

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

WANTED—Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," POWER.

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn street, Chicago.

AGENTS WANTED for first-class steam specialty in use throughout United States. Address C. S. Wood, 410 S. 15th St., Philadelphia, Penn.

SALES AGENTS to sell steam turbine blowers, feed water regulators, ventilating fans, pumps, etc.; guaranteed territory; commission. Wing, 90 West St., New York City.

WANTED—Experienced salesman to sell the Rolin patent adjustable grate bar; exclusive territory and liberal commission. Write Standard Grate Company, Heed building, Philadelphia.

DRAFTSMAN WANTED—An experienced mechanical draftsman, preferably with a technical education, or a number of years' practical shop experience, by a large manufacturing concern in Massachusetts; state age, experience and salary expected by addressing Box 367, POWER.

WANTED—By a large New York electric light company, operators and dynamomen familiar with alternating- and direct-current systems; men with two and three years' experience will be accepted and advanced rapidly; state age, experience, education and salary desired. Box 364, POWER.

SUBSTANTIAL mining company in Mexico require the services of an A-1 experienced master mechanic, thoroughly up in electrical and mechanical engineering, and mining and milling machinery in general; give full particulars and references; salary $200. Address "L. T. C.," Box 374, POWER.

A YOUNG MAN to take charge of boiler houses of a large steel plant in the Chicago district; must have previous experience and good record in a similar position and must have thorough knowledge of economical production of steam; replies should state experience, references and salary expected. Address "P. L. V.," 1300 Trude Bldg., Chicago.

SITUATIONS WANTED

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

SUPT., M.M., or chief engineer; practical and technical training, manufacturing construction, foundry, hydraulic, electric, marine, railroad and stationary engineering. Box 368, POWER.

WANTED—Position by young man as dynamo tender or switchboard attendent; three years' experience in electrical power plant work, including wiring and construction; understand Corliss and other types of engines. Box 372, POWER.

MISCELLANEOUS

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

Patents. C. L. Parker, Patent Attorney, ex-examiner Patent Office, 904 G St., Washington, D. C. Write for Inventor's Handbook.

ENGINEER AND FIREMEN—Send 10 cents in stamps for a 40-page pamphlet containing a list of questions asked by an examining board of engineers. Stromberg Publishing Co., 2703 Cass Avenue, St. Louis, Mo.

PATENTS—H. W. T. Jenner, patent attorney and mechanical expert, 608 F St., Washington, D. C. I make investigations and report if patent can be had and exact cost.

EVERY ENGINEER should be posted regarding the new system of vacuum heating installed without payment of royalty; I have valuable information; write today. T. L. Reeder, 1417 W. Jackson Blvd., Chicago, Ill.

WE WANT the agency of American manufacturers of goods that are required by machinists and engineers; we are importers of American engineering specialties and manufacturers' sole agents for Austria, Hungary and Balkan states, and have ample show rooms and offices. John Kollin & Co., General Office, Budapest, Hungary.

FOR SALE

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

FOR SALE—125 h.p. Westinghouse gas engine, complete with ignition set, first class condition. Address Box 373, POWER.

FOR SALE—Small screw cutting lathe, chuck and tools; fine condition; bargain. South Bend Machine Co., 424 Madison St., South Bend, Ind.

FOR SALE—20x48 Wheelock engine and two 72"x18' high pressure tubular boilers in good condition cheap. Address "Engineer," Box 2, Station A, Cincinnati, Ohio.

FOR SALE—One 2000-h.p. Wheeler surface condenser with vacuum and centrifugal circulating pumps. Reply to Purchasing Dept., Sulzberger & Sons Co., Chicago, Ill.

FOR SALE—50-h.p. Westinghouse induction motor, type C. C. I., 200 v. 116 a., 2 phase, 60 cycle 300 ft. No. 0 wire; 200-a. 4-pole switch; six 175-a. fuses, all new. Box 371, POWER.

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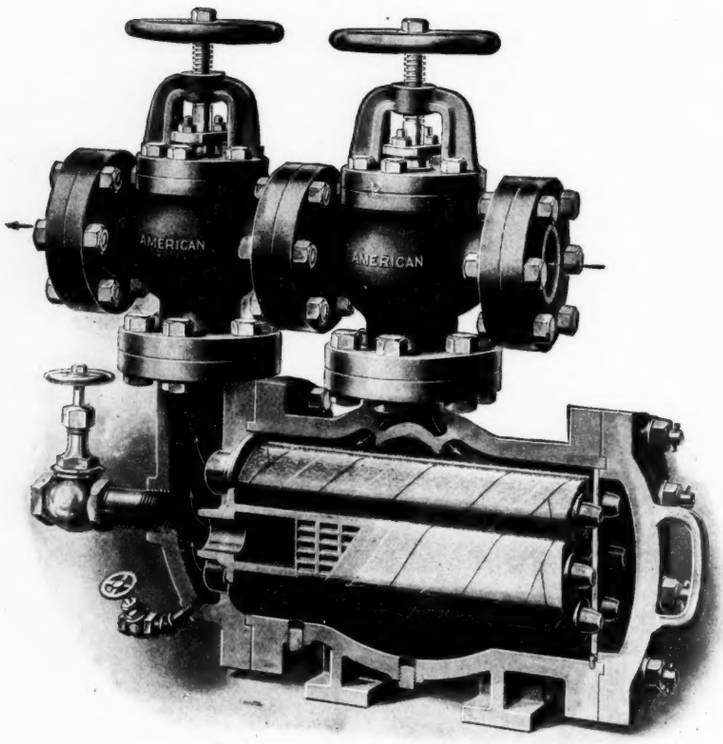

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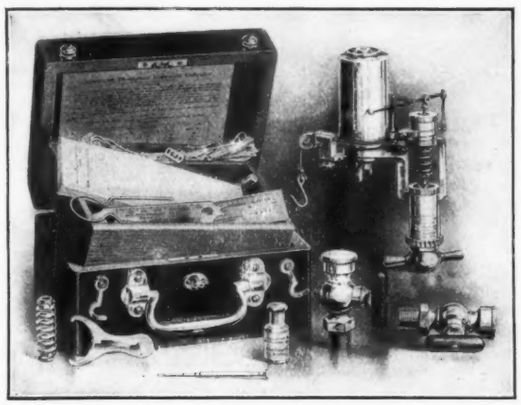

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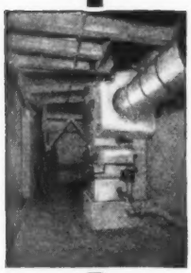
Smooth-On Mfg. Co. 6

ALL THE BIG CONCERNS USE COCHRANE HEATERS

Every Steam Plant Should Have One



A Cochrane Heater utilizes exhaust steam to bring the boiler feed water up to 210° F.

Each ten degrees that the water is raised in temperature corresponds to a saving of 1 per cent. of the fuel bill, that is, if the temperature is raised from 60° to 210°, 16 per cent. of the total fuel bill is saved.

Heating the water up to 210° performs much work which would otherwise have to be done by the boiler heating surface. The boiler heating surface can transmit as much heat as before, and therefore the addition of a Cochrane Heater increases the boiler steaming capacity by one-sixth.

In other words, six boilers and a Cochrane Heater can do as much work as seven boilers fed with cold water, and make as much steam.

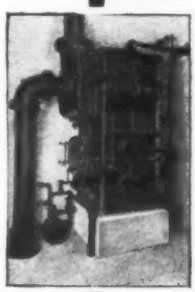
Heating the water by spraying it through the steam bath of a Cochrane Heater drives off air and gases, in the absence of which corrosion of boilers and piping does not occur.

The driving off of carbon dioxide by heat results in the conversion of the carbonates of lime and magnesia into the insoluble monocarbonates, which precipitate out in the heater, and therefore do not form scale in the boiler.

If the water contains permanent hardness also, that is, sulphates, nitrates and chlorides, the functions of the Cochrane Heater can be extended to provide for their conversion into monocarbonates, so that the boilers will be free from corrosion and hard scale, and can be washed out perfectly with water from a hose.

Clean boilers mean less work and less expense for repairs and cleaning.

We are always glad to help engineers with drawings and suggestions regarding suitable layouts to secure the best results in the removal of oil or water from steam, the utilization of exhaust steam or the heating or softening of water for boiler feed and other purposes. Submit your requirements and they will receive our prompt consideration.



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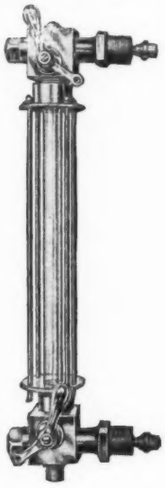
Graber Indicating, Automatic Water Gauge

A water gauge that is safe—it has an automatic valve which closes instantly in case a gauge glass breaks, thus shutting off flow of steam or water and removing any danger of scalding.



The indicating lever on outside of gauge shows position of the automatic valve and as the valve cannot move without changing position of the lever there can be no danger of false water level.

It is made in two patterns, one for pressures up to 125 lbs.—the other for pressures up to 250 lbs.

Ball Gauge Cock With Jenkins Composition Plug

This is a long lasting gauge cock, simply constructed, always to be relied on for perfect service.

The Jenkins Packing used to make the seat lasts for years and when necessary can be renewed at slight cost.

The seat is always tight; when the packing is worn by use, all that is necessary to renew the joint is to true up the end of the packing piece with a file or sand paper and to turn the screw up until the ball stands horizontal.

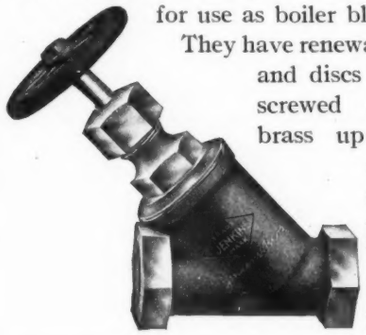
Four Jenkins Bros. Boiler-Room Needs

Jenkins Bros. "Y" Or Blow Off Valves

These are strong, well made valves, capable of standing hard usage without giving way.

They have a full opening nearly in line with the pipe and consequently permit a free flow of steam or fluids.

For which reason they recommend themselves for use as boiler blow-off valves.



They have renewable seat rings and discs and are made screwed or flanged—brass up to 3″ from standard and extra heavy patterns - iron body from 2″ up, standard patterns only.

Jenkins Bros. Swing Check Valves

These valves are also splendidly adapted for boiler feed service and similar work as, like the "Y" valves, they offer practically no obstruction to the flow of steam or fluid.

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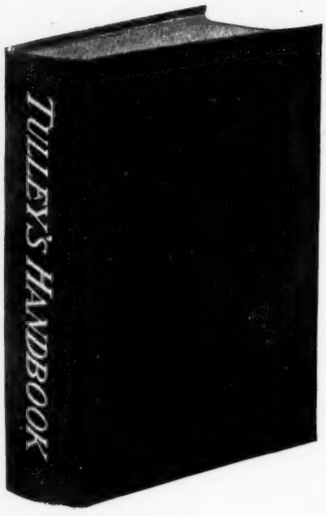

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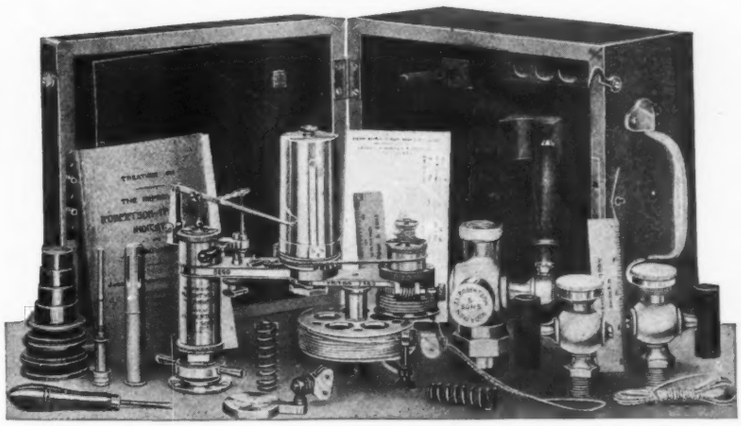

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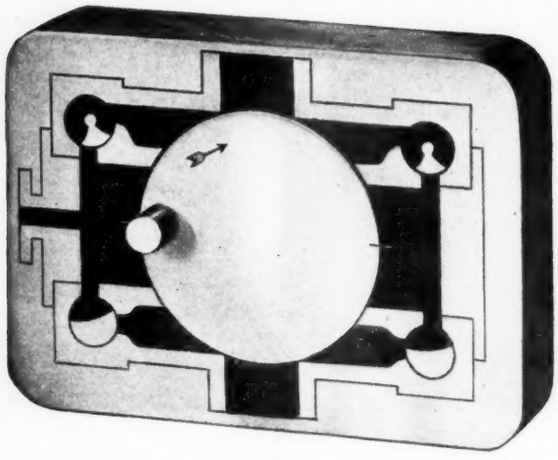

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A Few Valuable Moments

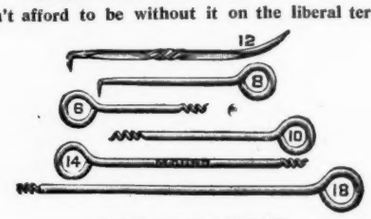
spent with the "Ad. Editor" each week will interest, entertain and instruct.

The "Ad. Editor" knows something about modern publicity and preaches the gospel of truth and sincerity in advertising.

He has a word to say this week on page 65 about little power-plant leaks and their prevention.

THIS SET OF (6) MOUND PACKING TOOLS BELONGS IN YOUR KIT

and you can't afford to be without it on the liberal terms we offer.



.....SEND THIS COUPON.....

MOUND TOOL & SCRAPER CO., Seventh and Hickory Sts., St. Louis, Mo.

Gentlemen:-Enclosed find one ($1.00) Dollar for which send me one set of (6) Mound Nickel Plated Packing Tools, price $2.25, and I hereby agree to remit balance, one dollar and twenty-five cents (1.25), within sixty days.

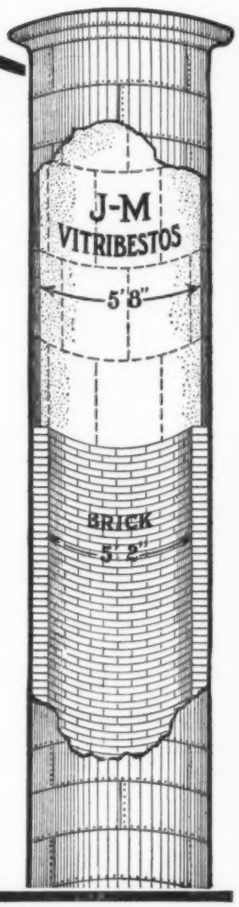
Name ....Address .....

Save Your Stack from Corrosion!

Steel smoke stacks require protection from the corrosion caused by acids, sulphurous and other gases of combustion, rust, etc. If this protection is not provided, they soon pit, rust, corrode and become weakened and worthless.

It pays to avoid all this trouble by lining the stack with

J-M Vitribestos Stack Lining



This lining, being made of the indestructible mineral Asbestos (vitrified), successfully withstands the attacks of acids, gases, excessive heat, rust, etc.

It is only one-tenth the weight of fire brick. This means a less expensive foundation.

It is but 2 inches thick, while most linings are 5 inches thick, so gives greater flue area. On a six-foot diameter stack this increase in flue area, due to the use of J-M Vitribestos, amounts to 15 per cent., and as the efficiency of a stack varies according to its area, an increase here means greater efficiency and a better draft.

It will pay you to look into this matter by writing our nearest Branch for our interesting booklet *today*.

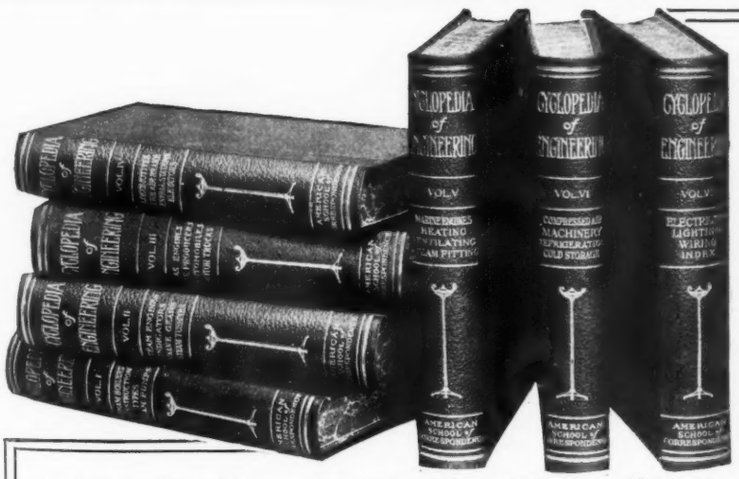
H. W. JOHNS-MANVILLE CO.

Manufacturers of Asbestos and Magnesia Products, ASBESTOS Asbestos Roofings, Packings, Electrical Supplies, Etc.

Baltimore, Boston, Buffalo, Chicago, Cleveland, Dallas, Detroit, Kansas City, London, Los Angeles, Milwaukee, New York, Minneapolis, New Orleans, Philadelphia, Pittsburg, San Francisco, Seattle, St. Louis

For Canada: THE CANADIAN H. W. JOHNS-MANVILLE CO., LIMITED,
Toronto, Ont., Montreal, Que., Winnipeg, Man., Vancouver, B. C.

1337



We want every Stationary, Electrical, Central Station and Power Engineer to Examine this great work.

We will place this wonderful

CYCLOPEDIA of ENGINEERING

in your home or office absolutely free of charge.

Examination will prove to you, the value of this great work; how necessary it is to your success; that these books contain just that information which you are looking for, that will make you a bigger and broader man in your trade or profession. To hold a bigger job with a bigger salary, to be recognized as an authority on Practical Steam and Power Engineering you must know every detail, be familiar with every technical and theoretical point. This cyclopedia gives you just that necessary information in the most complete, get-at-able form.

Power, 2-7-'11

These seven volumes contain 3,200 pages of the most thorough treatise on engineering ever published. The chapters on construction of boilers, care and operation of steam, gas and oil engines, valve gears, power transmission, refrigeration, and management of dynamo-electric machinery are especially complete. The text is supplemented with hundreds of full-page plates, photographs, diagrams, formulas, etc. The books are beautifully bound in half red morocco; the titles stamped in 23-karat gold.

THIS IS OUR LIBERAL SELLING PLAN

The seven complete volumes will be sent you, express prepaid, for 5 days' free examination upon receipt of the coupon. If you find the books to be all we say they are, and more, and you decide to keep them, send us your initial payment of $2.00 within five days and then remit $2.00 every month until you have paid the special price of $18.80. The regular price is $25.00. If, after thoroughly examining the books, you do not see your way clear to keep them, notify us and we will send for them at our expense and the whole transaction will not cost you one cent. Think over this Liberal Selling Plan. Isn't it worth while? Send the coupon today.

IMPORTANT SUBJECTS COVERED

Indicators—Valve Gears—The Steam Turbine—Compression and Absorption Refrigeration—Condensers—Navigation—Valve Motion—Air Brakes—Principles of Heat—Chemistry—Construction of Boilers—Calorimeters—Theory of Dynamo-Electric Machinery—Direct Current Dynamos—Direct Current Motors—Storage Batteries—The Lathe—The Planer—The Shaper—Systems of Warming—Furnace, Steam and Hot Water Heating.

For a short time we will include as a monthly supplement, for one year, the TECHNICAL WORLD MAGAZINE. This is a regular $1.50 monthly, full of Twentieth Century Scientific Facts, written in popular form. Also contains the latest discussions on timely topics in invention, discovery, industry, etc.

AMERICAN SCHOOL OF CORRESPONDENCE :: CHICAGO, U. S. A.

FREE EXAMINATION COUPON

A.S.C.

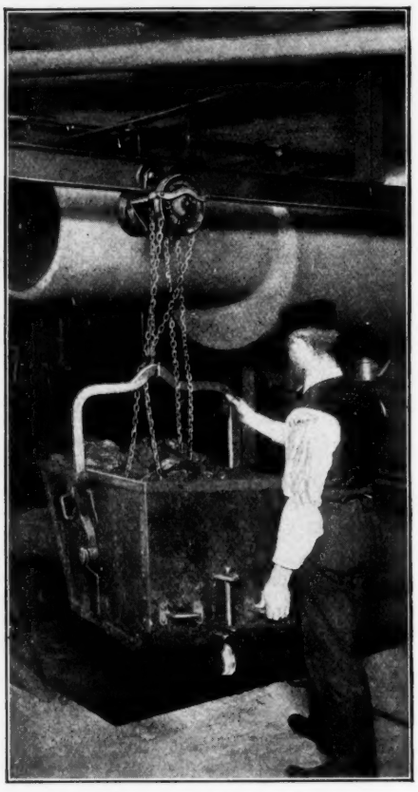
Please send set Cyclopedia of Engineering for 5 days' free examination; also Technical World for one year. I will send $2.00 within 5 days and $2.00 a month until I have paid $18.80 or notify you and hold the books subject to your order. Title not to pass until fully paid. Power 2-7-11.

Name .....

Address .....

Occupation .....

Employer .....



Triplex Block on a Trolley for handling coal and ashes in a boiler room. Buckets of 500 lbs. capacity are found most convenient.

Good-bye Wheelbarrows!

One man with a Triplex Block on a trolley does more work in a day than three men with wheelbarrows.

That's one saving.

And a Triplex Block will outwear any number of wheelbarrows.

That's two savings.

And those savings soon pay you back the whole cost of installation and then turn into dividends.

Most people would call that a real investment!

TRIPLEX BLOCKS } **16 Sizes:** One quarter of a ton to forty tons. **300 Active Stocks** ready for instant call all over the United States.

The Book of Hoists tells much—for a postcard.

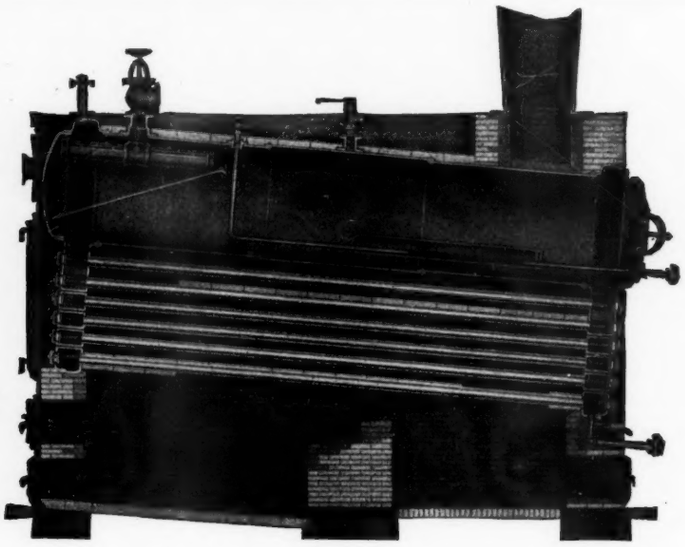
The Yale & Towne Mfg. Co.

Also Duplex Blocks, Differential Blocks and Electric Hoists.

Makers of Yale Products
Locks, Padlocks, Builders' Hardware, Door Checks and Chain Hoists.

9 Murray St., New York
Local Offices: Chicago, Boston, Washington, San Francisco

Canadian Warehouse: The Canadian Fairbanks Co., Ltd. Offices in all the large cities of Canada.



Wilkinson Safety Water Tube Boiler

Patented.

All flange steel construction—Great responsiveness to overload demands—Absolutely perfect circulation—Special cleaning advantages—Minimum Setting space—Durability of parts—Equal expansion—Dry Steam—Economy.

The above features commend the Wilkinson Boiler to all steam users. Write for Bulletins Nos. 1451 and 1471.

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Executive Office, Pittsburg, Pa.

Boiler Department
OSWEGO, N. Y.

New York Office, 90 West Street